

Technical Report 1123

Analysis of Infantry Situation Awareness Training Requirements

Laura D. Strater, Debra Jones, and Mica R. Endsley
SA Technologies

November 2001



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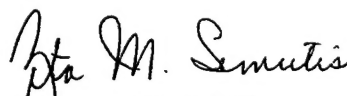
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FOREWORD

The Infantry Forces Research Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences conducts research investigations to identify and understand the challenges presented by the 21st Century digital battlefield. To optimize the allocation of limited financial and temporal resources, endeavors aimed at modernizing Infantry forces cannot be achieved haphazardly, but must be guided by thorough research. By targeting efforts in areas identified by research as most likely to produce significant improvements, maximum benefits can be provided for Infantry forces at a reasonable cost in both financial resources and training time.

This study investigated significant factors contributing to the situation awareness (SA) of platoon leaders and provided a look at how those factors interact with decision-making through three main thrusts. Since information acquisition and usage are integral in attaining and maintaining situational dominance for a fighting force, a survey completed by experienced trainers of new Infantry platoon leaders examined areas in which new officers are both successful and unsuccessful in attaining SA. This analysis provides a framework for developing technologies and training methods to improve SA in Infantry operations. An investigation into the relationship between specific SA elements and various types of decisions was conducted to discover some of the ways SA impacts decision-making. An exploration of existing research on SA also identified areas that hold promise for training SA to accelerate the acquisition of skills and expertise. A plan was proposed to develop training programs to improve SA skills in new platoon leaders.

This investigation identified areas of SA that are considered problematic by the soldiers who train new platoon leaders, highlighting high-impact target areas for future training efforts. The range of responses and variety of items shown to be a problem for SA also provide support for the idea of the multifaceted nature of SA within the Infantry venue. Relationships were found between SA and decision-making, demonstrating additional ways in which SA can be leveraged and trained not only to enhance SA, but also to support and improve the decision making process. This research forms the basis for the development of training programs that can better equip our fighting forces to gain and maintain high levels of SA in the challenging environment of Infantry operations. Major findings and future research plans were briefed on 26 October 2001 to COL Walter L. Holton, the TRADOC Systems Manager-Soldier, as well as to a group of representatives from the U.S. Army Infantry School's Combined Arms and Tactics Directorate and its Directorate of Operations and Training.


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Technical Director

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We would like to thank Dr. Scott Graham and Dr. Kenneth Evans of ARI for their guidance and support of this project. The assistance of Mrs. Nancy McClure, Dr. Richard Christ, and Dr. Ken Evans of ARI was invaluable in distributing the SA surveys to the appropriate personnel. We also appreciate the willingness of Dr. Robert Pleban of ARI to share the raw decision data from a prior study to help us investigate more fully the relationship between SA and decision-making.

We would like to thank all the individuals who took the time to complete and return the Infantry Instructor Survey on Platoon Leader Situation Awareness. We understand that your time is valuable, and your willingness to participate in this endeavor has made a significant contribution to our understanding of the SA requirement of platoon leaders.

Finally, a special thanks goes to Mr. Scott Swetnam for his invaluable assistance in acting as a subject matter expert for this project. His contribution to this effort was vital to the success of the study.

EXECUTIVE SUMMARY

Research Requirements:

As the Army begins to capitalize on information technology to improve information flow to the battlefield, inexperienced platoon leaders will increasingly be called upon to function at high levels of effectiveness in an information-rich, complex and dynamic environment. Success in Infantry missions requires acquiring intelligence information from a variety of sources, selecting from among competing and often conflicting cues to identify key information to assist in the development and implementation of plans, and doing it better and faster than the enemy. Situation awareness (SA) provides the framework for the warfighter to acquire and utilize available information to improve critical factors such as lethality, survivability, security and communications. Although current Army requirements call for the improvement of SA across all echelons, no training programs specifically geared to enhance SA have yet been developed.

The objective of this investigation is to identify areas where training can be applied to reduce deficits in SA, particularly among inexperienced officers. Since many new officers are assigned to lead a platoon, platoon leaders were selected as the focus for the investigation. Platoon leaders generally direct their troops from a vantage point not far removed from the action. Thus, they operate in a harsh, stressful and complex environment where they must attend to multiple sources of information, prioritize among competing goals, make rapid decisions and take action to implement these decisions. Under these conditions, superior SA adds another powerful weapon to the warfighter's arsenal.

Procedure:

The current investigation addressed three objectives. First, a literature review was conducted to identify prior research into SA, with an emphasis on SA in the Infantry domain. Particular emphasis was given to investigations comparing components of SA between more and less proficient individuals. Next, data from a prior study on SA and decision-making was examined to uncover clues to the relationship between SA and subsequent decisions. Data pertaining to a participant's SA at a given moment in time were compared to data from the participant's decisions made in close temporal proximity. Finally, Infantry trainers with experience training platoon leaders completed a survey to identify the SA strengths and weaknesses of new platoon leaders. All tasks focused attention on areas where it might be possible to capitalize on patterns of SA that vary between more and less proficient individuals with the goal of leveraging these differences into training programs to improve SA in novice platoon leaders.

Findings:

The literature review identified several areas where prior studies have indicated differences between the SA of experienced and inexperienced individuals. Specific differences are found in task management and prioritization, pre-mission planning, contingency planning,

goal setting, pattern matching, levels of SA attended to, information seeking and self monitoring, among others.

Additional analysis of the data from a prior study involving both SA and decision-making found several interesting relationships. Officers with higher Level 1 SA were more likely to follow the rules regarding initiating communications with their commander. In general, though, better higher level SA was linked to a decreased likelihood of rigidly following expected norms of communication in coordinating with other platoons, communicating to their commander, and requiring communication from their platoon. It is possible that these communications are deemed less vital precisely because these officers have a good understanding of the situation. In contrast, officers with better higher level SA were also better at providing complete orders to their own platoon. Here, the officer is relaying information rather than seeking it. Although these findings must be viewed with caution, they provide some indication into the processes by which SA influences decision-making.

Survey respondents identified several areas as sources of significant SA problems for new platoon leaders. For Level 1 SA, detection of the relevant cues in the environment, trainers indicated two primary areas of concern: communication and detection of information about the enemy. For Level 2 SA, comprehension of the meaning of cues, trainers identified an inability to form a coherent picture, not specifying alternate courses of action, not understanding task priorities and not understanding the enemy as problem areas. For Level 3 SA, projecting into the future, trainer saw lack of contingency planning, usage of ammunition, likely enemy course of action, and location of enemy troops around heavy weapon as areas where projection is poor for new platoon leaders. Additionally, overall problems were seen in mission planning, time management and task prioritization.

The investigation established that the development of SA is a significant concern to the trainers and that opportunities exist to improve SA among new platoon leaders. It provides further proof that SA can be successfully studied in the light Infantry environment, and demonstrates the utility of such studies.

Utilization of findings:

These findings can be used to develop training programs specifically designed to improve the SA of platoon leaders, particularly inexperienced platoon leaders. This investigation utilized three approaches:

1. Identifying SA deficits in new platoon leaders,
2. Understanding how SA changes with experience, and
3. Investigating the relationship between SA and decisions/actions.

By combining these approaches, we can search for areas of convergence which indicate training opportunities that will produce not only troops with enhanced SA, but will also improve the ability of the troops to utilize their SA to make the best decisions and plans with the information available.

ANALYSIS OF INFANTRY SITUATION AWARENESS TRAINING REQUIREMENTS

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Introduction

The objective of this research effort was to form the basis for creating an Infantry Situation Awareness Training (ISAT) Program. Battlefields of the future will be continually more digitized, with the ability to supply data to a wider audience at an ever-increasing pace. Warfighters could, and undoubtedly will, be more furiously inundated by bits of data than by enemy fires. More data, however, does not equate to more or better information. Even the best of digitized systems are rarely able to present information to the individual neatly packaged and processed into the precise bit of knowledge needed at the moment, presented in the most useful and comprehensible format. Rather, pertinent data is mixed in with a great deal of irrelevant and often conflicting data, and the individual must sort through the mire to find that information which impacts upon the mission, goals, and tasks at hand. Warfighters in this future battlefield (and in operations other than war) will still need to assess information from this complex environment and put it together with that supplied by evolving digital systems to create a mental picture of the current situation. This mental picture, which forms the basis for all decision-making and action, has been termed situation awareness.

What is SA?

Situation awareness (SA) in its simplest terms involves knowing what is going on around you, using that knowledge to understand the current state of the environment and project future impact. A more comprehensive, widely accepted definition of SA is ***"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future"*** (Endsley, 1988, p.97). Embedded within this definition are many of the concepts that articulate a complete understanding of SA.

First, SA consists of three levels: perception, comprehension and projection. Level 1 SA, perception, involves detection of significant cues and elements in the environment. Level 2 SA, comprehension, involves incorporating the information acquired into the framework of the individual's goals and tasks to understand how the bits of data will impact those goals and tasks. It also involves combining the individual pieces of information together to form a comprehensive picture of the world. Level 3 SA, projection, involves extrapolating the information in time to determine how it will impact future states of the environment.

Additionally, the definition refers to a temporal and locational component of SA. Time is an important concept in SA, as SA is a dynamic construct, changing at a tempo dictated by the surrounding action. The individual's SA provides a representation of the world at a specific moment in time and in a given location. As new inputs enter the system, individuals must incorporate them into this mental representation, making changes as necessary in the plans and efforts implemented to achieve the desired goals. The concept of SA also involves knowledge about the activities and events occurring in a specific location. While the SA of a battalion commander and the SA of one of the platoon leaders in the battalion might cover some of the same area, the level of detail and specific area of primary focus are different. A platoon leader will focus only on his own area of operations (AO), though he will naturally have a certain

amount of interest in actions occurring in adjacent areas, while the battalion commander will be focused upon a broader area with a significantly different level of granularity.

Why study SA?

Situation awareness is a fundamental requirement for warfighter success in both the present and in future battlefields. SA provides the foundation for military decision-making, and the framework in which all plans and actions are conceived. Thus, while SA does not directly predict decision-making or task performance, individuals with good SA will have a significantly higher probability of making good decisions and achieving successful outcomes in their endeavors than will individuals with poor SA.

In the demanding environment of Infantry combat, enhancing SA will yield dividends by providing information dominance, improving security and survivability, and optimizing lethality. With the application of enhanced information technologies, training must focus on techniques to improve the ability of warfighters to select the pertinent and critical cues from competing and often conflicting information sources. These techniques must be based, however, upon sound research that promotes better understanding of the factors influencing Infantry SA and the relationships between these factors. The technologies and programs to develop forces with superior levels of SA must be built upon a foundation of solid research and knowledge regarding the key factors that fuel SA in the Infantry arena.

SA in Infantry Operations

Endsley, Holder, Leibrecht, Garland, Wampler and Matthews (2000) developed an Infantry-focused SA model that serves as a useful introduction to issues of SA in Infantry operations (Figure 1). Data or information are acquired from the external world via inputs from electronic systems, other individuals, and direct observation. In return, SA also influences the inputs into the system by directing attention to cues believed to be significant based on the individual's internal model of the world. Expectations, goals and objectives shape the individual's SA by influencing the perception, comprehension, and projection of information. This information, such as enemy and friendly intentions, actions and status, weapons available, weather and terrain, are then incorporated into the individual's mental representation of the environment, his SA. The challenges of task and environmental factors such as battle tempo, fatigue, and physical and mental condition also influence the soldier's SA.

Fundamental to the acquisition of SA are an array of individual factors. Skills, such as communications, scan patterns, and team processes, influence the acquisition of SA, while knowledge bases, such as mental models or schema, influence the processing of information into a coherent picture. Cognitive coping mechanisms ease the cognitive demands on the system; enabling the individual to handle the information overload through processes like automaticity and pattern matching. Finally, the cognitive abilities and limitations of the individual have considerable impact upon SA. Motivation and attitude influence all these factors, affecting the

acquisition and development of skills, knowledge bases, cognitive coping methods, and even the individual's abilities and limitations.

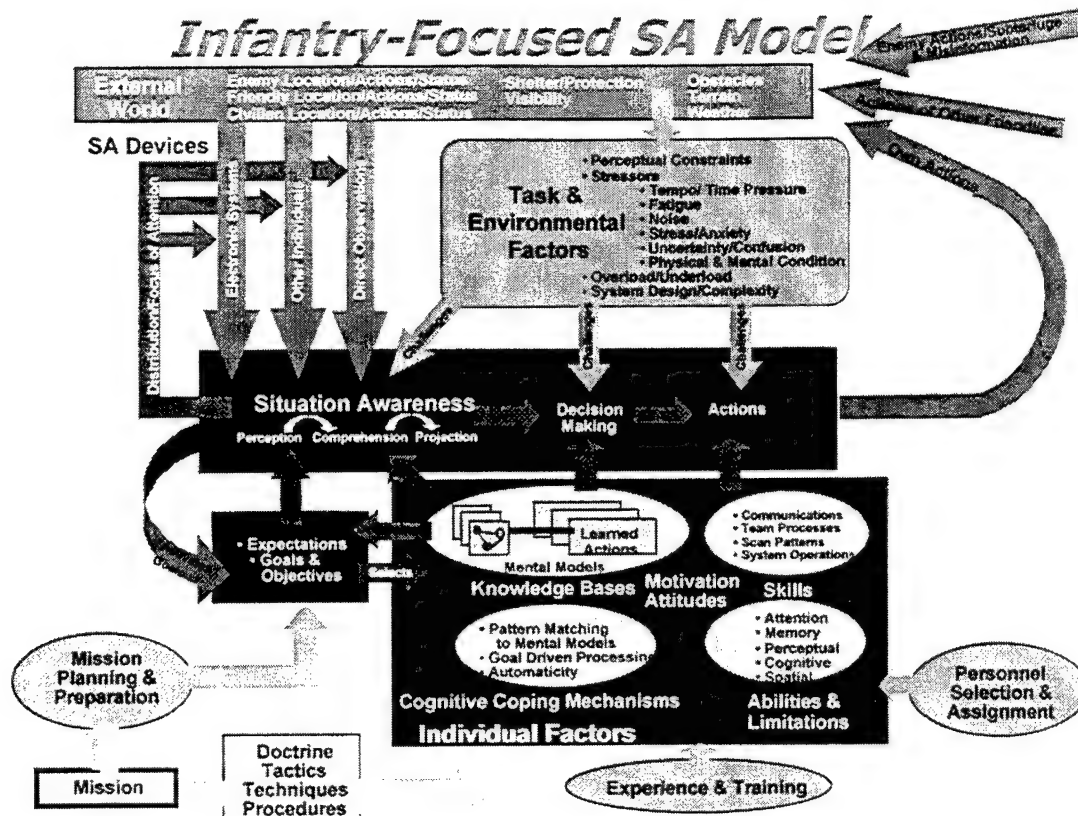


Figure 1. Model of Infantry SA (From Endsley, et. al, 2000)

The Infantry soldier (or commander) must function within a highly variable and demanding environment. Noise, heat and cold, fatigue, poor weather, smoke and rugged terrain are all realities of the Infantryman's world that challenge the development of SA. Further, they will face an intelligent enemy who seeks to disrupt SA through deception, misinformation and directly altering the tempo of the battle. Decision making in the face of uncertain, missing and conflicting information is common.

Numerous individual cognitive processes will greatly affect the ability of a warfighter to gain SA under such harsh conditions. Limited attention and working memory mechanisms will constrain the soldier's ability to gather and assimilate novel information on battlefield operations. The development of relevant long-term memory stores (knowledge bases) for pattern matching to observed environmental information, goal-directed processing, and automaticity of actions through experience and training are identified by the model as the primary mechanisms used for overcoming these limitations to achieve high levels of SA and successful performance.

First, experienced soldiers often have internal representations of the environment they are dealing with—a mental model. A well developed mental model provides: (1) knowledge of the

relevant “elements” of the environment that can be used in directing attention and classifying information in the perception process (Level 1 SA), (2) a means of integrating elements to form an understanding of their meaning (Level 2 SA), and (3) a mechanism for projecting future states of the environment based on the current state and an understanding of its dynamics (Level 3 SA). During active decision making, a soldier’s perceptions of the current state of the environment may be matched to related schemata in memory that depict prototypical situations or states of the mental model. These prototypical situations provide situation classification, understanding, and projection of what is likely to happen in the future. For example, the observed pattern of troop movements may be matched to known doctrine for that enemy, to very quickly classify and understand what tactics are being employed, and thus what actions they may be expected to take. These mental models and schema are what allow experienced Infantry commanders to almost automatically understand what is happening, even on the basis of a few key cues.

Secondly, in processing dynamic and complex information, such as in Infantry operations, soldiers need the ability to rapidly alternate between data-driven and goal-driven processing. They need to quickly switch between seeking information to assist their pursuit of a specific goal and responding when perceived data serve to activate a different goal. An important issue for achieving successful performance in Infantry operations lies in the ability of soldiers to dynamically juggle multiple competing goals effectively. This capability is greatly affected by training and experience.

Thirdly, an Infantryman’s SA can be affected by automaticity of information processing. Automaticity may be useful in overcoming attention limits, but can also leave the soldier susceptible to missing novel stimuli. Over time, it is easy for actions to become habitual and routine, requiring a very low level of attention. In general, a high level of automaticity is desirable for psychomotor tasks (such as rifle firing or hand-to-hand combat), but not for the cognitive portion of the task (such as directing attention to external cues and making decisions as to the best course of action).

Based on this model, we can argue that critical abilities for SA in Infantry operations may include attention sharing capacity, working memory capacity, perceptual abilities (including perceptual speed), cognitive analytical skills (including pattern matching), and spatial abilities. While many of these factors have been found to be important to SA in other domains, including piloting and driving (Endsley & Bolstad, 1994; Gugerty & Tirre, 1997; O’Hare, 1997), no studies have yet been conducted to extrapolate these findings to the Infantry arena. Further investigation of those abilities that distinguish great commanders and Infantrymen who possess high levels of SA from others should be conducted so trainable abilities can be fostered in others.

Situation awareness training strives to modify these initial individual factors and, thus, to enhance the information processing capabilities of the soldier by providing experiences and opportunities for the development of a richer understanding of the combat environment. Additional key skill areas identified by this model as potential training targets include communications and team processes. Development of mental models, pattern matching to schema and development of automaticity are mechanisms training can impact to lead to better SA. The model also incorporates higher level meta-cognitive skills involving the development

of accurate expectations (through pre-mission planning), contingency planning and self-checking which may be trained to enhance SA.

Overview

To date, no training programs have been specifically developed to create and enhance situation awareness in Infantry officers. While in some cases individuals are able to develop the needed skills and knowledge bases for good SA on their own, other individuals appear to be lacking in SA. This deficit is often particularly apparent in the least experienced officers. For this reason, the investigation focused on SA among platoon leaders, often the first opportunity to lead troops for a new army officer. The objective of the initial effort of this program is the identification of critical skills and knowledge necessary for good SA in Infantry operations. These efforts will form the foundation for the subsequent development of a training program for enhancing soldier SA. The present research included several main thrusts:

(1) A detailed literature review of situation awareness research and training, as well as the training of cognitive skills in Infantry operations, was conducted.

(2) Available SA data for Infantry personnel were evaluated to identify and analyze factors related to high and low SA. Data available from Infantry personnel across variable experience levels were examined. Analyses of these data were used to determine critical issues for SA in Infantry operations.

(3) A survey was developed and distributed to both officers and non-commissioned officers experienced in training and leading platoon leaders. The survey investigated their experiences related to SA and SA problems in the Infantry environment, both from their individual viewpoint and in terms of where they see trainees and other Infantry personnel having problems. The survey elicited key tasks, behaviors, environmental features and other factors associated with SA problems. This survey, along with the detailed SA data analysis, will serve to ensure that key cognitive skills and abilities critical to Infantry SA are identified for further analysis and training.

Building on the review of training approaches discussed here and other ongoing work related to training SA, the best strategies to pursue for creating subsequent SA training programs were identified.

Literature Review

Relevant research from past U.S. Army research papers, with a special emphasis on Infantry operations, was identified to discern opportunities for implementing the lessons learned. As the concept of SA was developed in the highly digitized, information dense environment encountered by airplane pilots, much of the research has been conducted in this venue. While there are likely to be differences between the SA operations and transformations utilized in the technologically advanced cockpit and those utilized in the extreme conditions encountered in

Infantry operations, it is also expected that a preponderance of the underlying processes will be similar. Thus, while we have tried to focus on research into Infantry SA, research from other domains that supports the general tendencies found in the Army literature is also included in the belief that it will add depth to this investigation.

Key Army leverage points for enhancing SA have been identified as mission planning and preparation, experience and training, and personnel selection and assignment (Endsley et al., 2000). The focus of the current effort is to enhance situational dominance through development of training strategies that allow the Infantry to boost the SA of its forces, providing a force multiplier effect.

Some of the individual factors underlying SA are known to be trainable, either through carefully developed training programs and exercises or through actual combat experiences. This exposure facilitates the development of a rich set of knowledge bases (in the form of mental models and schemata of prototypical situations connected to well learned actions) upon which SA is dependent in complex and dynamic operations. The Army has long recognized the crucial role of such experiences in building a capable fighting force. Other critical skills may also be trainable. Perhaps more can be done to exploit these training arenas for developing the robust and varied knowledge bases that are critical for superior SA across an array of situations. Several possibilities may be determined from the literature.

Team Skills - SA is dependent on certain critical skills that span the organization. In Infantry operations these may include communicating with adjacent units, subordinates and commanders; team processes present in the unit, including factors such as leadership, teamwork, and information sharing norms; observation and surveillance skills that are taught; and proficiency with the sensors and systems that are provided. Individual motivation and attitudes can also have a direct impact on the effectiveness of training in developing and employing these critical skills.

Task Management & Prioritization – Interruptions, task related distractions, other distractions and overall workload pose a high threat to SA. Good task management strategies appear critical for dealing with these problems. Schutte and Trujillo (1996) found that the best performing teams in non-normal situations were those whose task management strategies employed a prioritization strategy based on the perceived severity of the tasks and situations. Those who used an event/interrupt driven strategy (dealing with each interruption as it came up) and those who used a procedural based strategy performed more poorly. The ability to accurately assess the importance and severity of events and tasks is an important component of Level 2 SA. This understanding allows individuals to actively manage their task and information flow so as not to end up in situations in which they are overloaded and miss critical information.

Pre-Mission Planning – Pre-mission planning forms the basis for SA, creating expectations to which future events and environmental features are matched (Endsley, 1995). Experts and novices differ in significant ways in the manner in which they plan for future activities. Despite significant differences in experience and familiarity with tasks and situations, an investigation of battlefield planning found no differences in time required for planning with experience. More experienced planners did not develop plans more quickly than novices, but

rather spent additional time carefully investigating the details of the situation prior to plan development (Serfaty, Macmillan, Entin, & Entin, 1997). Similarly, a study of preflight behavior found that more experienced pilots completed more thorough preflight preparation than less experienced pilots (Prince & Salas, 1998). A study of the characteristics of superior teams found that flight crews that displayed better performance spent more time in an active information-acquisition process before developing a plan or considering options, in contrast to poorer performing crews, who spent less time gathering information, but rather moved quickly into option comparisons (Schutte & Trujillo, 1996). In generating courses of action (COA), experts tend to generate a broad initial COA, and then utilize additional information to refine their COA over time. Alternatively, novices tend to generate a far more specific and detailed COA, and sometime retain these initial plans despite information to the contrary (Klein & Calderwood, 1996). Another study of planning behavior showed that, while officers knew their Commander's Intent (CI) two levels up, they rarely incorporated it into their planning process (Geiwitz, 1994). Without intentional application of the information, goals and plans are frequently developed that meet mission requirements without optimizing the outcome to achieve the CI. By providing training to improve the planning process, individuals will establish the foundation for superior SA at the beginning of a mission, increasing the likelihood of enhanced SA in later stages.

Projection (Level 3 SA) and planning – Contingency planning has been noted as a critical skill that can lead to high levels of SA (Endsley, 1988, 1995). Amalberti and Deblon (1992) found that a significant portion of experienced pilots' time was spent in anticipating possible future occurrences. This gives them the knowledge (and time) necessary to decide on the most favorable course of action to meet their objectives. Experienced pilots also appear to spend significant time in pre-flight planning and data gathering and engage in active contingency planning in flight, similar to the battlefield planning described earlier (Serfaty et al., 1997). Each of these actions serves to reduce workload in critical events. Using projection skills (Level 3 SA), these pilots are able to actively seek important information in advance of a known immediate need for it and plan for various contingencies. Not all planning is equally effective, however. Taylor, Endsley and Henderson (1996) found that teams who viewed only one plan were particularly susceptible to Level 2 SA errors, failing to recognize cues that things were not going according to plan. Actively planning for various contingencies, considering actions the enemy is likely to take as well as actions the enemy could take that would prove most dangerous to the current mission and objectives is critical. Contingency planning promotes a deeper level of understanding by encouraging consideration of varied aspects of the situation, identifying potential problem areas before they occur, and developing responses prior to critical events.

Goal Structures - Differences have also been found in the goal-setting behaviors of experts and novices. Despite low articulation of goals or evidence for goal setting (Calderwood, Crandall, & Baynes, 1988), Cohen, Thompson, Adelman, Bresnick, and Riedel (1999) found that after training, experts were better at setting clearly defined goals than novices. They also found differences in the functional level and time frame, with experts focusing more on longer-term goals and setting goals to meet higher level objectives and purposes.

Pattern Matching – Pattern matching between situation features and learned situation schemata has been noted as critical to SA in dynamic environments such as combat operations

(Endsley, 1988). Although experts are able to classify situations by performing pattern matching operations to situations previously encountered, they rarely rely on simple pattern matching but rather use it as a tool to guide their understanding of the situation. Experts look at a situation to determine how it differs from a mental model or a pattern previously encountered (Serfaty et al., 1997). Experts spend more time verifying their information, specifically, they seek information that provides a contraindication for the selected COA, while novices seek information that supports their plans (Klein & Calderwood, 1996). Experts view a novel situation as complex, focusing on the differences between the current situation and previously encountered situations, while novices see situations as simpler, focusing on the similarities with prior situations (Serfaty et al., 1997). The propensity to play devil's advocate serves to strengthen the plans of experts, making them less vulnerable to unexpected situations, and allowing them to get into the mind of the enemy, seeking holes in their own plans and defenses that the enemy might be able to exploit. This research shows that while experts use the results of pattern matching, they think carefully about the pattern to be applied. When encountering novel situations, they critically consider the details of previously encountered patterns and the specifics of the current novel occurrence, to assess the impact of the divergence from the pattern.

Comprehension and Projection - Some studies have shown that experts and novices may focus the majority of their attention on different levels of SA. For example, experts attend more to context (Level 2) while novices concentrate on surface cues (Federico, 1995). Experts look at the cues within the context of the situation to infer meaning from the sum total, while novices attempt to infer meaning from cues somewhat independent of context. Similarly, one study of decision making found that while novices focused on the Level 1 SA details, such as enemy equipment, experts focused on the big picture, the comprehension and projection elements of SA (Klein & Calderwood, 1996). This finding is also supported by an aviation study showing that pilots with greater experience focus more on comprehension and projection, Level 2 and 3 SA, than do novices (Prince & Salas, 1998). In other research, when expert and novice firefighters were presented with similar cues, experts addressed different issues than novices. Experts allocated attention to considering resource availability and adequacy for the job at hand, while novices paid little attention to these issues (Calderwood et al., 1988). In a study of decision-making in armored units, Brezovic, Klein, Calderwood, and Thordsen, (1987) found that students in an armored officer basic course noticed the same cues as the instructors training the course, but were unable to draw accurate inferences from the cues. Thus while the Level 1 SA of instructors and students was similar, students were unable to exploit the detection of the cue to discern its implications for their mission. Another study, however, found that more experienced platoon leaders were better at identifying the location of both enemy and own platoon units on a map, showing better Level 1 SA for both enemy and own platoon elements. They seemed to focus their attention on different aspects of the environment, however, as they had better comprehension and projection knowledge of enemy elements than less experienced officers, while less experienced officers had better comprehension of units of their own platoon than more experienced officers (Strater, Endsley, Pleban, & Matthews, 2001). Similarly, Shattuck, Graham, Merlo and Hah (2000) found that novice commanders requested more information on friendly troops, while more experienced commanders focused on gathering information about the enemy. The ability to know where to focus attention, to identify critical cues, and to interpret and understand their meaning is a vital skill in the development of higher-level SA.

Information seeking and self-checking activities - Those with high levels of SA have been found to actively seek out critical information. They are quicker to notice trends and react to events because of this. Furthermore, these individuals are good at checking the validity of their own situation assessments, either checking them against more information or comparing them to others' assessments (Taylor et al., 1996). This was found to be effective in dealing with false expectations and incorrect mental models. Other researchers have also suggested a "Devil's Advocate" strategy where people are encouraged to challenge their interpretations of situations (Klein, 1995, Orasanu, 1995). From his studies of experts, Shanteau (1992) identified several psychological characteristics of experts. They include extensive domain knowledge, an understanding of what is relevant, the ability to make sense of complex problems and to work well in stressful situations, ability to handle adversity, to identify conditions contrary to their expectations and understand the significance of the discrepancies, and to adapt to changing conditions. The ability to monitor assumptions and identify errors is a key skill in maintaining high levels of SA.

Schema Development - Fracker (1988) noted that, although schemata may demonstrate utility for developing SA by reducing workload and working memory demands, they also introduce bias into the information acquisition and interpretation process that can lead to errors. Schemata help to direct attention to information expected to be important, and, therefore, away from other information. If the wrong schema is activated, or if the situation changes in significant ways, persistence in application of the incorrect schema can lead to errors. In the aviation domain, Jones and Endsley (1996) investigated the causes of pilot errors and found that of the approximately 20% of errors attributable to Level 2 SA failure, 7% were the result of poor mental models, 6.5% were the result of application of the incorrect mental model, and 4.6% were caused by over reliance on default values in the model. Later, Jones (1997) investigated the impact of the incorrect mental model on Level 2 SA. After intentionally introducing incorrect information to induce application of an erroneous model, conflicting information was presented. Only 35% of these conflicting cues resulted in detection of the false model. This has serious implication for training to improve higher level of SA. Cohen, Freeman, Fallesen, Marvin, and Bresnick (1996) trained critical thinking strategies to army officers and found that they were able to improve their ability to identify false assumptions, or errors in SA, by analyzing key events. Success was also attained in improving officers' abilities to notice and infer the meaning of conflicting data, and to assess the rationality of assumptions. In this study, training served to help officers acquire strategies to develop compelling arguments both supporting and denying the validity of their conclusions. This training enhanced the trainees' ability to persuade both themselves and others to accept good assessments and reject faulty assessments. The ability to identify and amend faulty conclusions, while supporting and persuading others of the validity of correct conclusions, is vital to Infantry officers.

Training and Technology - A study of battlefield digitization found that commanders using a digital battlefield information display reported that, while the display helped locate friendly and enemy forces on the map, the passive information acquisition process actually impaired their understanding of the enemy's locations and intent. The actions required to process the information and physically locate enemy forces in the non-digitized condition assisted in their comprehension and projection processes. Thus, while presenting pre-processed information into an easily useable format seems to be a tremendous benefit, it must also be able

to actively engage the cognitive processing centers of the intended recipient. Although commanders using the digitized system felt somewhat disconnected from the battlefield, they were able to give much more precise information on the location, types and numbers of enemies encountered. The digitized system seemingly improved lower levels of SA for enemy information, while hindering the higher levels (McGuinness, Foy, & Forsey, 2000).

The same study, however, found that the digital display produced significant benefits in helping commanders maintain understanding of the friendly situation. Unlike information on enemy troops, which was updated as reported, this information was displayed automatically, with no requirement for verbal communication between headquarters and soldiers in the battlefield. Commanders felt this enhanced comprehension of the friendly situation was the greatest single benefit to the digitized display used. A downside noted by researchers, however, was that the clearer picture given of the friendly locations led to a tendency on the part of the commanders to micromanage the forces on the battlefield. As the U.S. Army is currently moving toward greater autonomy for lower echelon forces, this was seen as a disadvantage (McGuinness et al., 2000).

Ross, Pierce and Baehr (1999) investigated fire support training and found that simply introducing new technologies into existing curricula were not sufficient to improve training. Learning is facilitated through realistic experiences where soldiers are required to solve inherently intriguing problems. The soldier must be cognitively immersed in the challenge of the scenario for true learning to occur. Other investigations of training techniques find that soldiers learn practical thinking skills best either individually or in small groups (Fallesen, 1995), that tactical decision making is improved through building experience and that mental agility, the ability to think on one's feet, is developed through exposure to multiple and varied scenarios (Livsey, 1993). The training methods selected, then, should incorporate realistic, engaging scenarios, with compelling problems to be solved by the soldier.

These research findings shed some light on issues that may be important for enhancing SA in Infantry operations and provide critical details concerning the skills and abilities necessary for attaining superior SA. More detail, however, is needed regarding what factors lead to SA problems in Infantry operations as well as the qualitative and quantitative differences between those with better and poorer SA.

Analysis of Infantry SA Data

The initial thrust of this investigation examined data that were available from other studies or training initiatives within the Army arena, with the intent of identifying and evaluating areas of high and low SA. As expected, however, extensive searches of available databases provided few previous programs where sufficient data were available in a format that permitted assessment of the SA of the participants, or those factors that might influence that SA. Only one study yielded sufficient data in a format that allowed a detailed assessment of soldier SA. In that study, participants engaged in virtual reality mission simulations where data were collected on both decision-making and objective measures of SA (Strater et al., 2001). In the present effort, those data were analyzed in detail to determine which SA elements could predict good

decision-making and performance in Infantry operations. A complete description of the participants and methods can be found in the original report, though an abbreviated version is outlined here.

Method

Participants

Fourteen Infantry officers, seven lieutenants (mean age 23.7 years) and seven captains (mean age 27.9 years), participated in the study. None of the lieutenants had prior experience serving as platoon leaders, while all captains had served as platoon leaders.

Apparatus

Soldier Visualization System (SVS) - Three full-immersion SVS simulators from the Dismounted Battlespace Battle Lab's Land Warrior Test Bed at Fort Benning, Georgia, were employed; one for the platoon leader and two for role-playing squad leaders. The Commanding Officer (CO) used a joystick-controlled desktop version of the SVS system. Each of the three simulators consisted of a rectangular enclosure formed by a 9-ft by 8-ft (2.7 m by 2.4 m) projection screen on one wall with black, sound-dampening fabric on the remaining three sides to reduce extraneous light and minimize distractions from outside sources. One side of the rear panel in the participant's enclosure was tied back to permit observation by those recording the results of the study. Using a communication system similar to those commonly used in the field, participants were able to communicate with squad leaders, the CO, and the platoon sergeant. For a more complete description of the SVS simulation, see Pleban, Eakin, Salter, and Matthews (2001).

Materials

Automated Performance Assessment System. The actions of the platoon leader were recorded by a researcher from the U.S Army Research Institute for the Behavioral and Social Sciences (ARI) on a personal computer at specific decision points in the scenario, where actions by the platoon leader were expected. A graphic user interface (GUI) board showed each action expected of the platoon leader at each decision point, and any action not performed was noted. For example, at decision point 2 in the assault scenario, if the platoon leader failed to coordinate with the commander for the actions of other platoons, issue a complete FRAGO (fragmentary order), or if he successfully completed an unforecasted action, it was noted on the GUI board.

SAGAT. The Infantry platoon leader version of the Situation Awareness Global Assessment Technique (SAGAT) is a customizable PC-based computer program that presents up to 21 standard queries assessing all three levels of SA. Thirteen queries were deemed appropriate for the scenarios used and the capabilities of the SVS (Soldier Visualization Station) full immersion virtual reality simulator. The queries were presented at three discrete points in time during the simulated missions, established to correspond with specific decision points in the scenarios. The queries addressed major SA elements, such as location of strongest and weakest enemies and friendlies, number of casualties suffered by the platoon, and expected enemy and

civilian actions over the next five minutes. Table 1 contains a complete listing of the SAGAT queries provided, along with the response options. Each query was presented graphically on a computer monitor. A more complete description of the program, with illustrations of the actual screen images shown for each query can be found in Strater et al., (2001).

Table 1. SAGAT Queries

	Query	Response Options
1	Indicate the location(s) of each element on the map.	Enemies, Enemy Heavy Weapons, Myself, Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, Other Friendlies, Civilians, Commander
2	Which enemy element is your highest level threat?	E1-20 (enemies), W1-20 (enemy heavy weapons)
3	Which enemy locations are the weakest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
4	Which enemy locations are the strongest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
5	Which friendly locations are the weakest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
6	Which friendly locations are the strongest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
7	Which friendly forces are currently exposed to enemy fire/attack?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
8	Does the enemy know the location of your platoon?	Yes, No
9	How many casualties have you suffered?	0, 1, 2, 3, 4, 5, 6, 7, ..., 29, 30, >30
10	What do you expect the enemy to do in the next five minutes?	Attack, Nothing, Move positions, Defend, Retreat, Other
11	What do you expect civilians to do in the next five minutes?	Become hostile, Riot/attack, Form a crowd, Disperse, Nothing, Move positions, Get in the way, Other
12	Who has the advantage in the current situation?	Friendly troops, Enemy troops, Friendly and Enemy troops equal
13	Which friendly elements are NOT in communication with you?	Squad 1, Squad 2, Squad 3, Weapons Squad, Other Platoons, Supporting units, None

Small Unit Leader Decision-Making Scenarios

The scenarios were set in a small European-style town, a virtual representation of the McKenna MOUT training site at Fort Benning, Georgia. The two scenarios used for this study were Assault and Defend. In each scenario, between five and seven decision points occurred, where specific decision-making actions were expected, e.g., determine status of injured soldiers.

Simulated scenarios focused on the interactions between the platoon leader, his CO, three squad leaders, and platoon sergeant. Participants encountered a wide variety of events, for example sniper fire, injured soldiers/civilians, NBC (Nuclear, Biological, and Chemical) threat, death of CO. Scenario instructions required minimal movement from the platoon leader to maintain the focus of the exercise on the decision-making aspects of the scenarios rather than the mechanics of navigating the virtual world.

Procedure

Each platoon leader participated in all scenarios on one day. The order of participants (experienced vs. inexperienced platoon leaders) was alternated across days to prevent

confounding effects of improvements in trainers or training procedures over successive days. (For a more complete description of the procedures, see Pleban, et al. (2001).)

Training for the study consisted of a briefing on the study objectives, introduction to the SAGAT program through both written instruction and a hands-on demonstration, and training on the functioning and features of the SVS. At the completion of training, the participant received written profiles of the CO, the three squad leaders, and the platoon sergeant. These profiles provided cues to guide the platoon leader in making squad assignments. The CO then briefed the platoon leader on the mission, followed by questions, a short time to develop a plan, then briefing the squad leaders and platoon sergeant on the plan. At this time, the exercise began.

Participants encountered four scenarios, but only the second and third scenarios involved SA measurement via SAGAT. The Assault scenario was always presented second, (the first of the SAGAT scenarios) while Defend was presented third. During each scenario, an ARI researcher recorded data regarding the expected actions the platoon leader failed to take, along with any unforecasted action, while an independent Observer/Controller (O/C), uninvolved in the action, provided limited guidance to the platoon leader as needed. At the conclusion of each scenario, the O/C provided feedback on actions not performed or incorrect information relayed. Each scenario concluded with an After Action Review (AAR) by the CO.

When the action was frozen at three predetermined points in each scenario, the SAGAT administrator wheeled a laptop computer on a cart to the participant. Each SAGAT administration lasted a maximum of four minutes, less if the participant completed the battery of queries before time expired. The timer began as soon as the participant pressed the "Start" button to begin the session. The first query always required the platoon leader to locate all elements on a map. Subsequent queries were presented in random order. While the participant answered the computerized SAGAT queries, the CO completed a paper and pencil version of SAGAT, which was used as an answer key to score the platoon leader's responses. After each SAGAT freeze, the laptop was removed and the simulation resumed.

Results

Data analysis reported in the original study showed that more experienced officers demonstrated significantly better Level 1 SA for the locations of both enemy and own platoon elements. They were better at placing those elements on a map than were less experienced officers. They were also better at identifying the locations of highest threat and the strongest enemy location, both higher level SA components (Level 2/3). In contrast, less experienced officers were actually better at identifying the location of the strongest friendly location (Level 2 SA) than more experienced officers, despite their performance deficit in locating own platoon elements on the map. Since higher level SA is largely the result of mental processing performed on lower level information, it appears that more experienced officers focused their cognitive processing efforts on the enemy, while less experienced officers focused their attentional processing on their own troops. This significant difference in the qualitative and quantitative SA of experienced and inexperienced platoon leaders may have noteworthy implications for training to improve SA.

In the current effort, the SAGAT data were subjected to a detailed comparison with the decision data collected from the 14 platoon leaders within the same scenarios and directly following the SAGAT freezes. Twenty decision items were collected for each platoon leader in the Assault scenario, at five separate points in the scenario. Twenty-six items were collected from each platoon leader in the Defend scenario across seven points in the scenario, providing a total of 644 decision items for the fourteen participants across the two scenarios. See Table 2 for a complete list of the expected actions at each decision point in the two scenarios.

To facilitate data analysis, the platoon leaders' 644 decision items were combined into seven categories based upon the types of actions required. The categories used were: *Communication to Commander*, *Allocation of Personnel*, *Requires Communication from Platoon*, *Coordination with other Platoons*, *Provides Orders to Platoon*, *Compliance with Commander's Orders*, and *Conducts Unforecasted Action*. For a complete listing of the actions included in each category, see Table 3.

Each decision item was then paired to the SAGAT data collected at the scenario freeze immediately preceding or closest to the appropriate decision point. Results of a stepwise regression analysis of the decision categories with the SAGAT queries are shown in Table 4. These results should be viewed cautiously due to the small sample size, potential scenario effects and post hoc nature of the analysis. The models for Communication to Commander and Compliance with Commander's Orders showed particularly high predictive value for those decisions, ($R^2 = .403$ and $.305$ respectively) despite the small sample size. Models for Provides Orders to Platoon, Allocation of Personnel, and Conducts Unforecasted Action are also statistically significant, although smaller in magnitude ($R^2 = .243$, $.165$, and $.099$), indicating that these models account for less of the variance. Despite our cautious interpretation of the data, they do indicate some interesting findings relative to SA.

Communication to Commander included decision items such as *No SITREP (situation report) to Commander* and *Fails to request Reinforcements*. Failure to take the expected actions in these areas was predicted by inaccurate responses to queries regarding the number of casualties suffered by the platoon and whether the enemy knows the platoon location. At the same time, they were predicted by accurate responses to queries regarding the next enemy action and who has the advantage in the current situation. Thus, leaders who merely possessed good Level 1 SA (perception) were likely to follow procedures and communicate to the commander as expected, while leaders with good Level 2 and 3 SA (comprehension and projection) were less likely to communicate with the commander as expected, perhaps indicating a higher confidence in their own abilities or a false sense of security. While this is an interesting speculation, further investigation of these results is warranted before any claims can be made.

Similarly, failure to take the expected action regarding personnel allocation was predicted by accurate responses regarding future civilian actions, a Level 3 SA query. This result is more suspect, however, as civilians had no impact in one of the two scenarios investigated.

Table 2. Decision Actions Expected in Assault and Defend Scenario at Each Decision Point

Decision Point	Assault Scenario Action Items	Defend Scenario Action Items
1	No situation report to Commander	No situation report to Commander
	Does not request smoke	Tasks wrong (1st) squad
	Does not coordinate with other platoons	Fails to readjust defense
	Fails to obtain status of WIA (wounded in action)	Fails to require report on linkup
	Conducts unforecasted action	Conducts unforecasted action
2	Fails to coordinate	Fails to contact 1st squad leader
	FRAGO (fragmentary order) incomplete	
	Conducts unforecasted action	
3	Fails or hesitates to act	No situation report to Commander
	Action incomplete	Fails to readjust defense
		Fails to require report on linkup
		Sends wrong (rifle) team
		Conducts unforecasted action
4	Fails to coordinate with Commander for platoon acts.	Fails to send AT (antitank) team
	Fails to coordination - preparation to fire Javelin	
	Does not request to fire Javelin	
	FRAGO incomplete	
	Conducts unforecasted action	
5	Fails to immediately mask	No situation report to Commander
	Fails to search just tank	Fails to provide platoon instructions
	Fails to post guards	Fails to warn troops on civilian status
	No situation report to Commander	Fails to request reinforcements
	Conducts unforecasted action	Conducts unforecasted action
6		No situation report to Commander
		Fails to obtain wounded in action status
		Fails to call for cease fire
		Fails to provide platoon instructions
		Conducts unforecasted action
7		No situation report to Commander
		Fails to call for cease fire
		Fails to provide platoon instructions
		Conducts unforecasted action

Table 3 . Decision Categories and Actions

Decision Category	Decisions/Actions
Communication to Commander	No SITREP to Commander
	Does not request smoke
	Does not request to fire Javelin
	No SITREP to Commander
	No SITREP to Commander
	Fails to request reinforcements
	No SITREP to Commander
Allocation of personnel	No SITREP to Commander
	Tasks wrong (1st) squad
	Fails to readjust defense
	Fails to readjust defense
	Sends wrong (rifle) team
Requires communication from platoon	Fails to send AT team
	Fails to obtain status of wounded in action (WIA)
	Fails to require report on linkup
	Fails to require report on linkup
Coordination with other platoons	Fails to obtain WIA status
	Does not coordinate with other platoons
	Fails to coordinate with Commander for platoon actions
Provide orders to platoon	Fails to coordinate -preparation to fire Javelin
	Fails to contact 1st squad leader
	FRAGO incomplete
	Fails or hesitates to act
	Action incomplete
	FRAGO incomplete
	Fails to immediately mask
	Fails to search just tank
	Fails to post guards
	Fails to provide platoon instructions
	Fails to warn troops on civilian status
	Fails to provide platoon instructions
	Fails to call for cease fire
Compliance with commanders orders	Fails to provide platoon instructions
	Fails to coordinate
	No SITREP to Commander
	No SITREP to Commander
Conducts unforecasted action	Fails to call for cease fire
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action
	Conducts unforecasted action

Table 4. Stepwise Regression Analysis of Decision Categories with SAGAT

Decision Category	Model	df	F-Value	P-Value	R²
Communication to Commander	My Location Known (-) Number of Casualties (-) Next Enemy Action (+) Advantage (+)	4, 35	5.912	.0010	.403
Allocation of Personnel	Next Civilian Action (+)	1, 25	4.956	.0352	.165
Requires Communication from Platoon	Exposed Friendly (+)	1, 51	2.898	.0948	.035
Coordination with other Platoons	Weakest Friendly (+)	1, 37	2.350	.1338	.034
Provides Orders to Platoon	Exposed Friendly (-) Advantage (1) (-) Not in Communication (+)	3, 63	6.730	.0005	.243
Compliance with Commander's Orders	Highest Threat (+) My location known (-) Number of Casualties (+) Not in Communication (+)	4, 49	5.367	.0012	.305
Conducts Unforecasted Action	# Casualties (+) Next Civilian Action (+) Advantage (+)	3, 76	2.797	.0458	.099

Platoon leaders were more likely to conduct an unforecasted action, something not anticipated by scenario developers, if they accurately knew the number of casualties (Level 1), could predict the next civilian action (Level 3), and knew who had the advantage in the situation (Level 2.) This may indicate that leaders with better SA across levels are more innovative, able to think beyond traditional ideas and strategies.

Finally, failure to provide orders to the platoon as expected was predicted by inaccurate knowledge of who has the advantage in the situation and what friendly positions were exposed to enemy fire, and accurate knowledge of who was not in communication with the platoon leader. For this decision category, leaders with better higher level SA were found to be also better at providing complete and accurate orders to their own platoon. The difference in the direction of the finding for this decision category (as compared to some of the other decision categories) could also be a difference in the type of decision. In this case, the platoon leader is giving orders, recommending action, and not merely seeking or relaying information to others.

Conclusions

In summary, experienced platoon leaders were more focused on enemy disposition, including enemy location, strongest enemy location, and highest threat. Less experienced platoon leaders were more focused on friendly disposition. In addition, a direct link was found between SA and decision making in Infantry operations. Most notably:

- Communications are linked to SA
 - More likely to provide complete orders if they knew who was exposed to enemy fire and who had the advantage
 - Less likely to communicate with the commander if they knew the next enemy action and who had the advantage
- Following commander's orders
 - Less likely when they have direct knowledge of highest threat, number of casualties, troops not in communication
- Allocate personnel appropriately
 - Less likely when they can predict next civilian action
- Take unforecasted actions
 - More likely when they know the number of casualties, the side with advantage, next civilian action

These findings bear more investigation, but indicate intriguing possibilities regarding how platoon leaders link their SA to their behaviors in complex battlefield situations. It also indicates key areas where training might best be leveraged to improve communications and information flow in Infantry operations.

Situation Awareness Survey

A pen and paper survey instrument (PT No. 60-33) was developed for distribution to soldiers with experience training new platoon leaders. An SA requirements analysis of platoon leaders developed in previous research provided the foundation for items included in the survey (Strater et al., 2001). Survey development was a collaborative effort between experienced SA researchers and a subject matter expert with considerable experience serving as an Infantry officer. The purpose of the survey was to identify areas where experienced trainers find that new platoon leaders have problems with SA. The survey consisted of a list of items in each of four categories, three corresponding to the levels of SA; perception, comprehension, and projection; along with a final category of broadly applied performance items. For each item, participants rated it as "Not a major SA problem for new platoon leaders," "Moderate SA problems for new platoon leaders," or "Frequent SA problems for new platoon leaders."

Method

Participants

Forty-three of 60 surveys distributed were returned, for a 71.6% response rate. Respondents were highly experienced, with ten survey participants (23.3%) reporting between 6 and 11 years of active duty service, 31 participants (72.1%) reporting more than 12 years of active duty service, and two participants (4.7%) electing not to indicate years of service. Survey respondents ranged in rank from Corporal to Colonel, with 27 of the surveys returned by enlisted personnel (62.8%) and 16 returned by officers (37.2%). Figure 2 shows the distribution of study

participants by rank. Participants were also asked to indicate their total years of combat instruction experience (i.e., <6 years, 6-11 years, or >12 years) in 5 areas: Officer Basic, Ranger School, Airborne, Air Assault, and Special Forces. These results are shown in Figure 3.

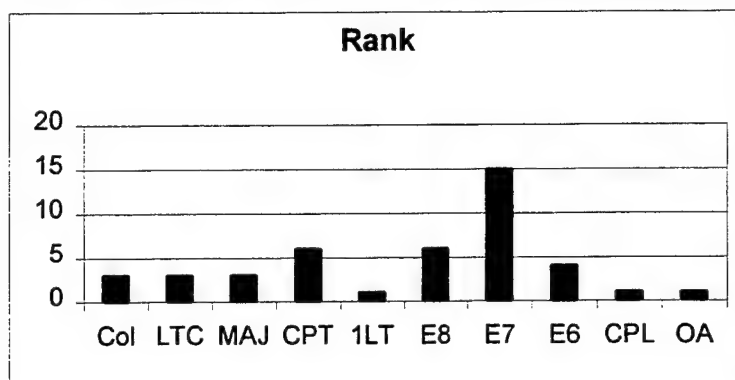


Figure 2. Rank Stratification

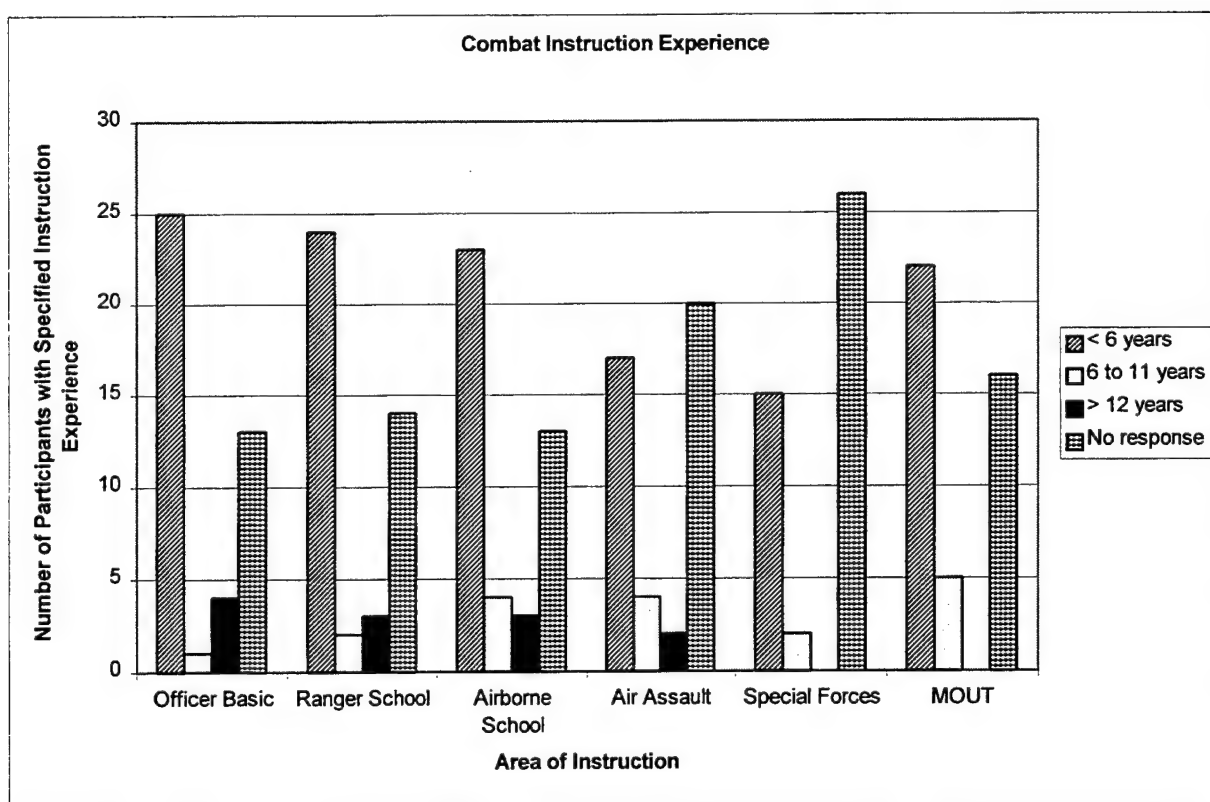


Figure 3. Combat Instruction Experience

Materials

Participants rated survey items to indicate the degree to which the rater believed each item caused SA problems for new platoon leaders. For items in section A, participants were asked to rate the extent to which failure to gather/detect critical information in the situation

pertaining to each item produced SA problems. Examples of these Level 1 SA queries include not determining terrain conditions, not requesting pertinent intelligence information, and not determining the combat readiness status of both the platoon and the opposing force. In section B, participants rated the degree to which failure to comprehend different aspects of the situation caused problems for platoon leader SA. Examples of these Level 2 SA items include not assembling bits of information together to form a coherent picture and not developing an understanding of the impact of terrain on mission and operations. In section C, participants were asked to determine the extent to which failure to project future situations, though the current situation is understood, poses problems for SA. Examples of items in this section include failure to project the effect of current combat power on ability to continue mission and failure to project likely enemy COA (course of action) from available information. In the final section, participants were asked to rate the extent to which failure to effectively perform the necessary mission tasks caused problems for SA. Examples of these items include poor time management, poor decision-making, and fatigue.

At the end of each section, participants were asked to place a check mark beside the items in that section that present the most serious SA challenges for new platoon leaders. Since the survey sections covering Level 1 and 2 SA contained significantly more items than the Level 3 SA and Performance items sections, five items were to be checked in these first sections and three items in the last two sections. The survey instrument is shown in Appendix A.

Procedure

Sixty surveys were distributed by hand to individuals in the Army who were involved in training platoon leaders at different phases of their careers. These individuals were asked to complete the survey and mail them to one of the researchers in the stamped envelopes provided. Surveys were not marked with identifying information, so while individuals were strongly encouraged to complete and return the survey, participation was completely voluntary.

Results

Survey Ratings

The results for all of the survey items are shown in Figures 4 through 12. For the purposes of this discussion, however, survey items receiving a rating of "frequent SA problems for new platoon leaders" from more than 25% of the respondents are listed in Table 5 and will be discussed further.

The results for survey questions pertaining to the failure to gather or detect critical information in the situation (i.e., Level 1 SA issues) are shown in Figures 4-8. Attentional narrowing, focusing on one aspect of the environment or piece of information, was indicated as a frequent problem, as were several intelligence gathering items; not requesting pertinent information, not employing squads to gather information, and not determining reliability of information. While numerous other items were rated highly, the survey identified two broad areas of special concern with many specific items causing frequent SA problems: poor communication and not determining the combat readiness status of the opposing force. These

results provide a clear indication of two major Level 1 SA problem areas for new platoon leaders. Of the nine communication items on the survey, seven (78%) were considered a more frequent problem for

Table 5. Survey queries receiving a rating of “frequent SA problems for new platoon leaders” from more than 25% of survey respondents.

Failure to Correctly Gather/Detect the Critical Information in the Situation Due to: (Level 1)	
Question	% of Respondents
Not detecting information due to attentional narrowing	27
Not utilizing a standard reporting procedure	30
Not carrying out standard operating procedure	28
Poor intelligence information due to	
Not requesting pertinent intelligence	31
Not employing squads tactically to gather needed information	30
Not determining reliability/timeliness of intelligence information	26
Poor communication caused by	
Not requesting information from squad leaders	30
Not requesting information from commander	30
Not communicating key information to commander	35
Not communicating key information to squad leaders	30
Not communicating key information to other platoons	44
Not monitoring company net	28
Not communicating overall situation/Commander's Intent to squads	28
Not determining own combat readiness status	
Experience and training	26
Timing/location of direct/indirect fire support	30
Not determining combat readiness status of opposing forces	
Number and severity of casualties	37
Physical fatigue	30
Mental fatigue	31
Movement and current position of troops	28
Weapons types, characteristics and quantities available	33
Location of direct/indirect fire support	44
Ammo and supplies availability	33
Availability of reinforcements	37
Heavy weapons location	40
Past behavior and tactics	26
Impact of current and future weather factors	26
Failure to Comprehend the Situation (even though basic information is detected) due to: (Level 2)	
Not assembling bits of information together to form a coherent picture	29
Not specifying alternate/supplemental plans/courses of action	32
Not developing an understanding of:	
Task priorities	33
Impact of soldier load and distance traveled on troop fatigue	33
Positioning soldiers to minimize the risk of fratricide	25
Enemy strengths and weaknesses	29
Likely areas of strategic significance to enemy	27
Enemy expectations of friendly actions	34
Failure to Project the Future Situation (though current situation is understood) due to: (Level 3)	
Lack of contingency planning	39
Failure to project the following:	
Usage rate of ammunition and supplies	36
Likely enemy COA from available information	33
Location of enemy troops around heavy weapons	32
Failure to Effectively Perform the Necessary Mission Tasks Due to: (Performance)	
Poor mission planning	27
Poor responses to unexpected/unplanned events	36
Poor time management	45
Poor task prioritization	28

SA by over 25% of survey respondents. Problems in communication range from not requesting information to not communicating key information. This is clearly an area of serious concern for trainers of new platoon leaders. The second Level 1 SA problem area was in gathering information on the combat readiness status of the opposing force. With 15 items on the survey, trainers identified 11 (73%) as posing a more frequent problem for SA. Trainers here identified such problem areas as not knowing the weapons types, characteristics and quantities available to the opposing force, to not having knowledge of the enemy's past behavior and tactics. The Level 1 SA items receiving the highest percentage of ratings of frequent problems for SA were "Not communicating key information to other platoons," along with two opposing force combat readiness status items, "Location of direct/indirect fire support" and "Heavy weapons location." All of these were rated as frequent SA problems for new platoon leaders by at least 40% of the trainers surveyed.

Survey results for questions pertaining to the failure to comprehend the situation even though the basic information is detected are shown in Figures 9 and 10. Comprehension problems include failing to assemble bits of information together into a coherent picture and not specifying alternate COAs as frequent problems for SA, along with not understanding task priorities, the impact of load and travel on fatigue, and soldier positioning to minimize fratricide. Finally, a continuation of Level 1 problems with detecting information about the enemy is seen. Instructors rated understanding enemy strengths and weaknesses, likely areas of strategic significance to the enemy, and enemy expectations of friendly actions as major problem areas for SA.

Survey queries concerned with failure to project future situations even though the current situation is understood are shown in Figure 11. Lack of contingency planning was identified as a problem area, as is failure to project the usage rate of ammunition and supplies. Again, problems with SA regarding the opposing force are seen at the projection level, as trainers noted that new platoon leaders have difficulty projecting a likely enemy COA, as well as their disposition around heavy weapons.

The results for the survey questions pertaining to the failure to effectively perform the necessary mission tasks are shown in Figure 12. These items are poor mission planning, poor responses to unexpected events, poor time management and task prioritization.

Overall, four questions received more ratings in the frequent SA problem category than in any other category:

- (1) Failure to gather/detect the critical information in the situation due to not communicating key information to other platoons (44%),
- (2) Failure to detect critical information in the situation due to not determining the opposing forces' location of direct/indirect fire support (44%),
- (3) Failure to gather/detect the critical information in the situation due to not determining the location of the opposing forces' heavy weapons (40%), and
- (4) Failure to effectively perform the necessary mission tasks due to poor time management (45%).

Many respondents considered these items to be the source of significant SA problems for new platoon leaders.

Factors Influencing Failure to Gather/Detect Critical Information: General

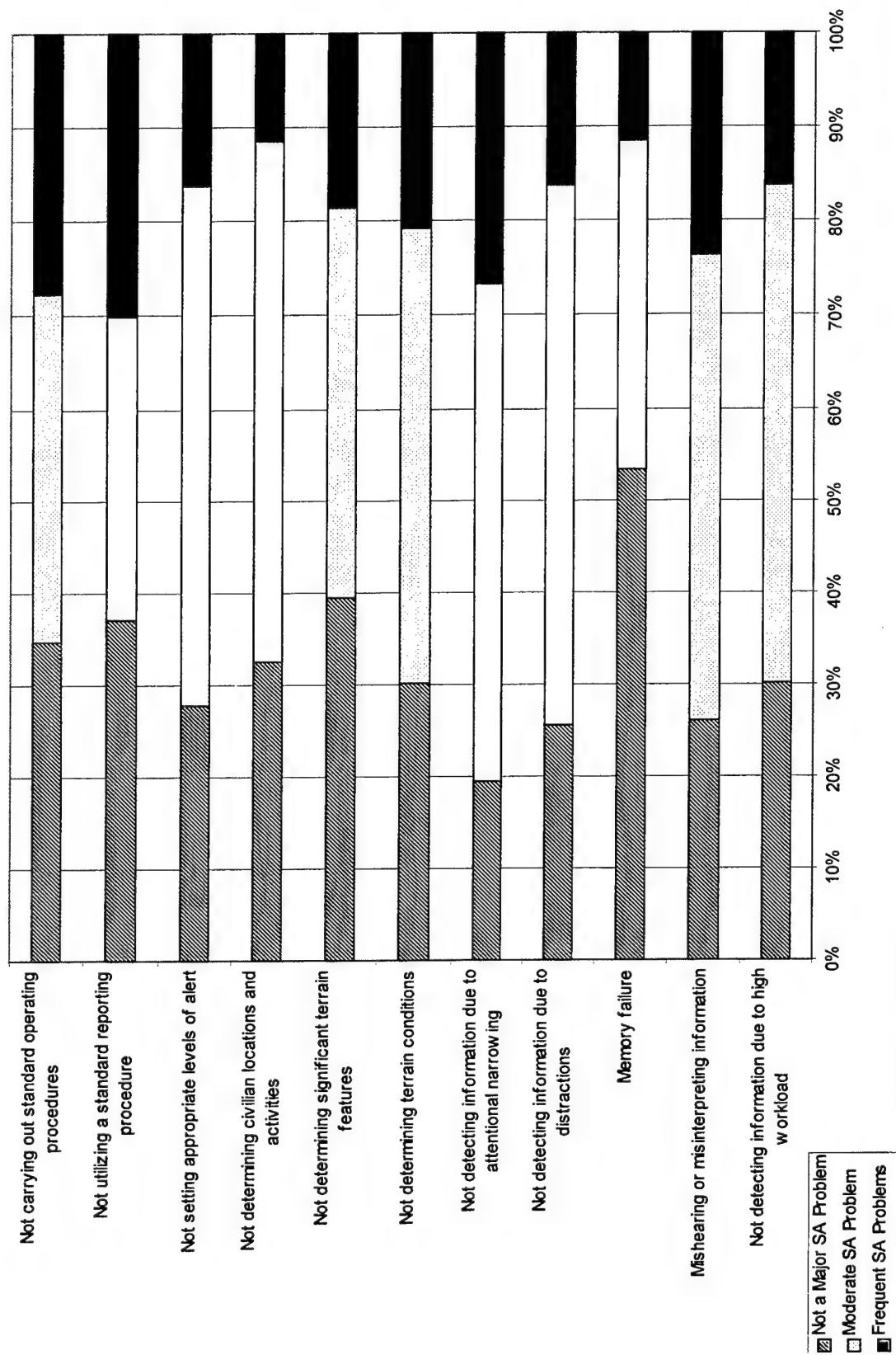


Figure 4. Level 1 SA Questions – General

Factors Influencing Failure to Gather/Detect Critical Information: Poor Intelligence Information

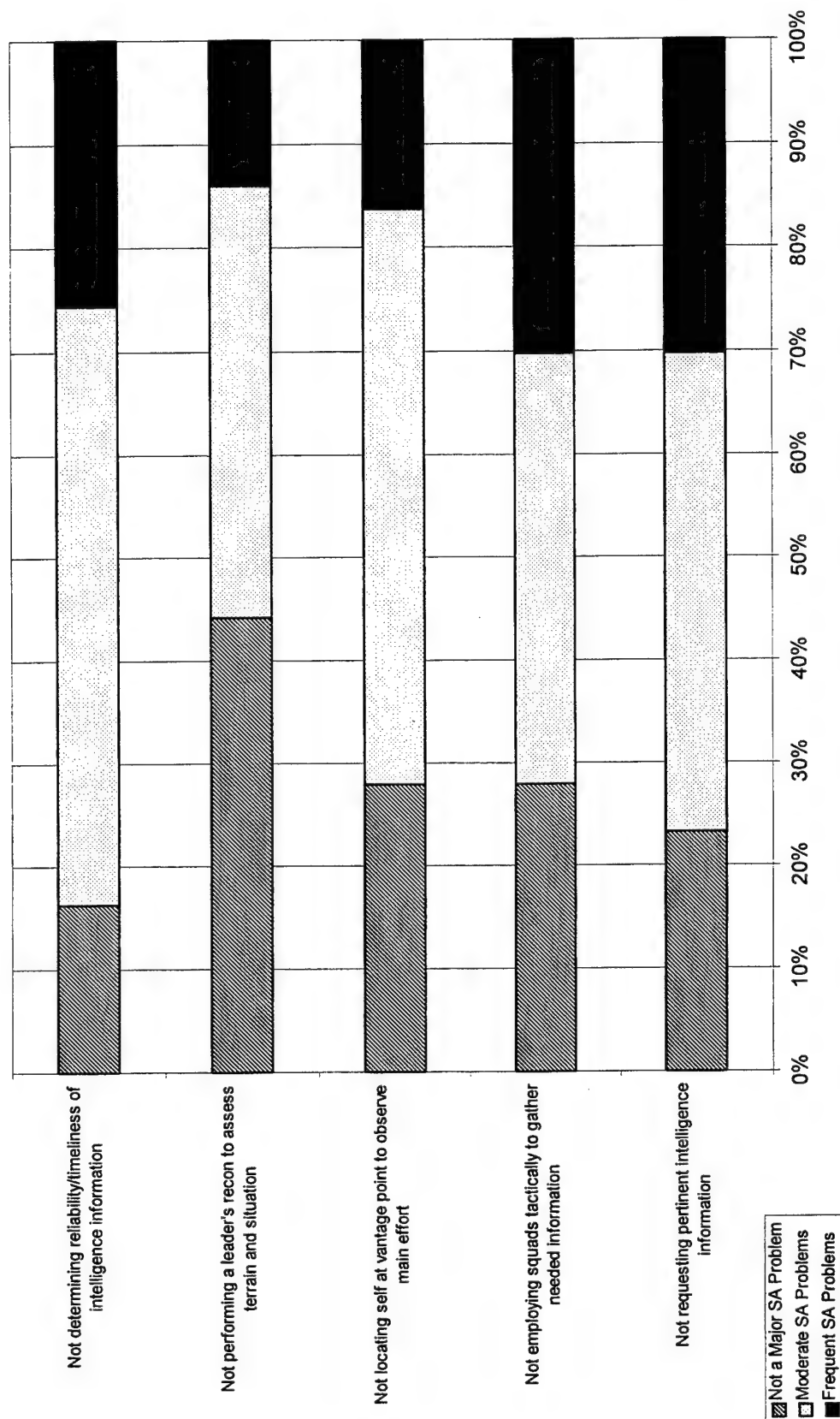


Figure 5. Level 1 SA Questions – Poor Intelligence Information

Factors Influencing Failure to Gather/Detect Critical Information: Poor Communication

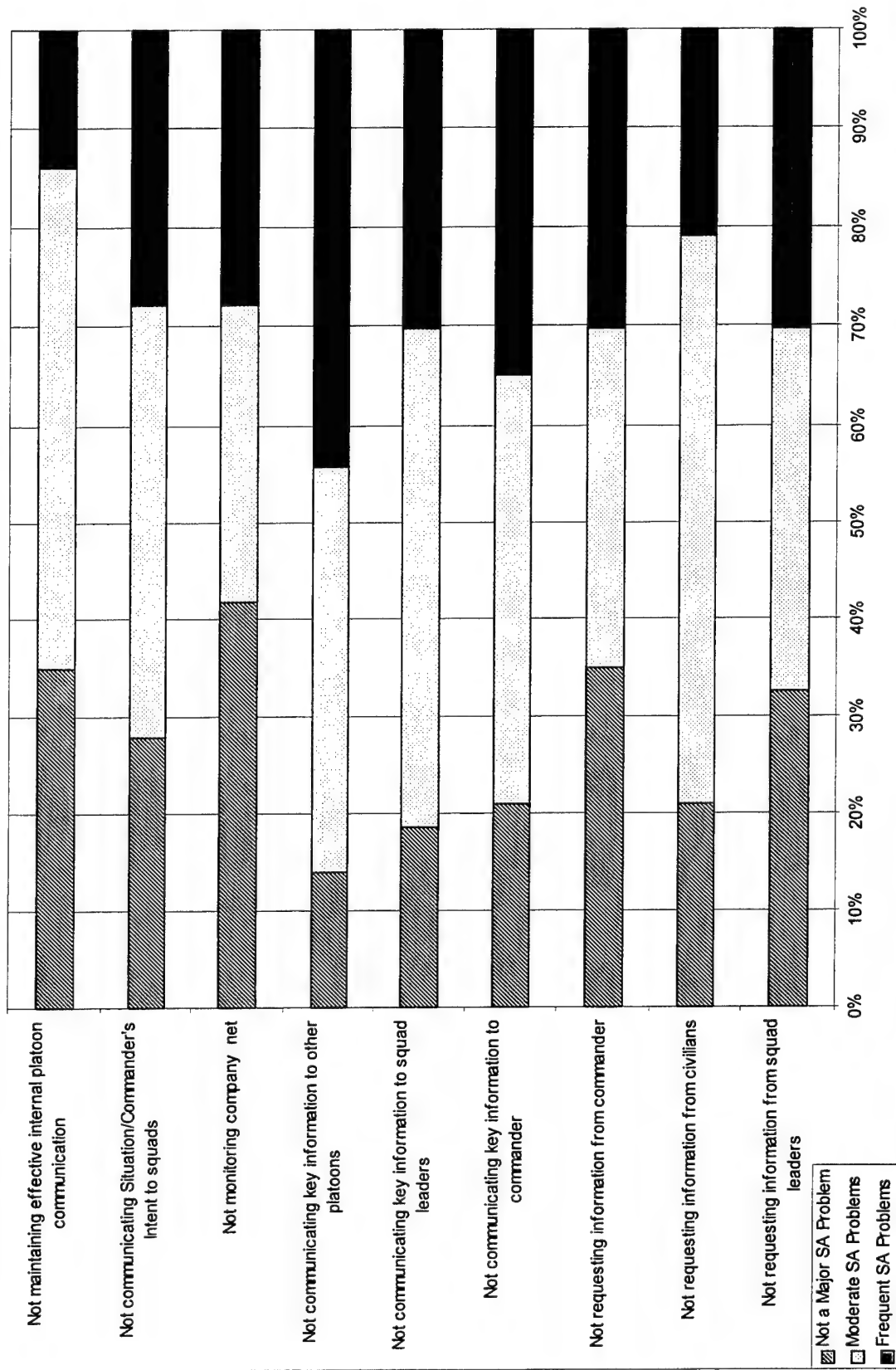


Figure 6. Level 1 SA Questions – Poor Communication

Factors Influencing Failure to Gather/Detect Critical Information: Not Determining Own Combat Readiness Status

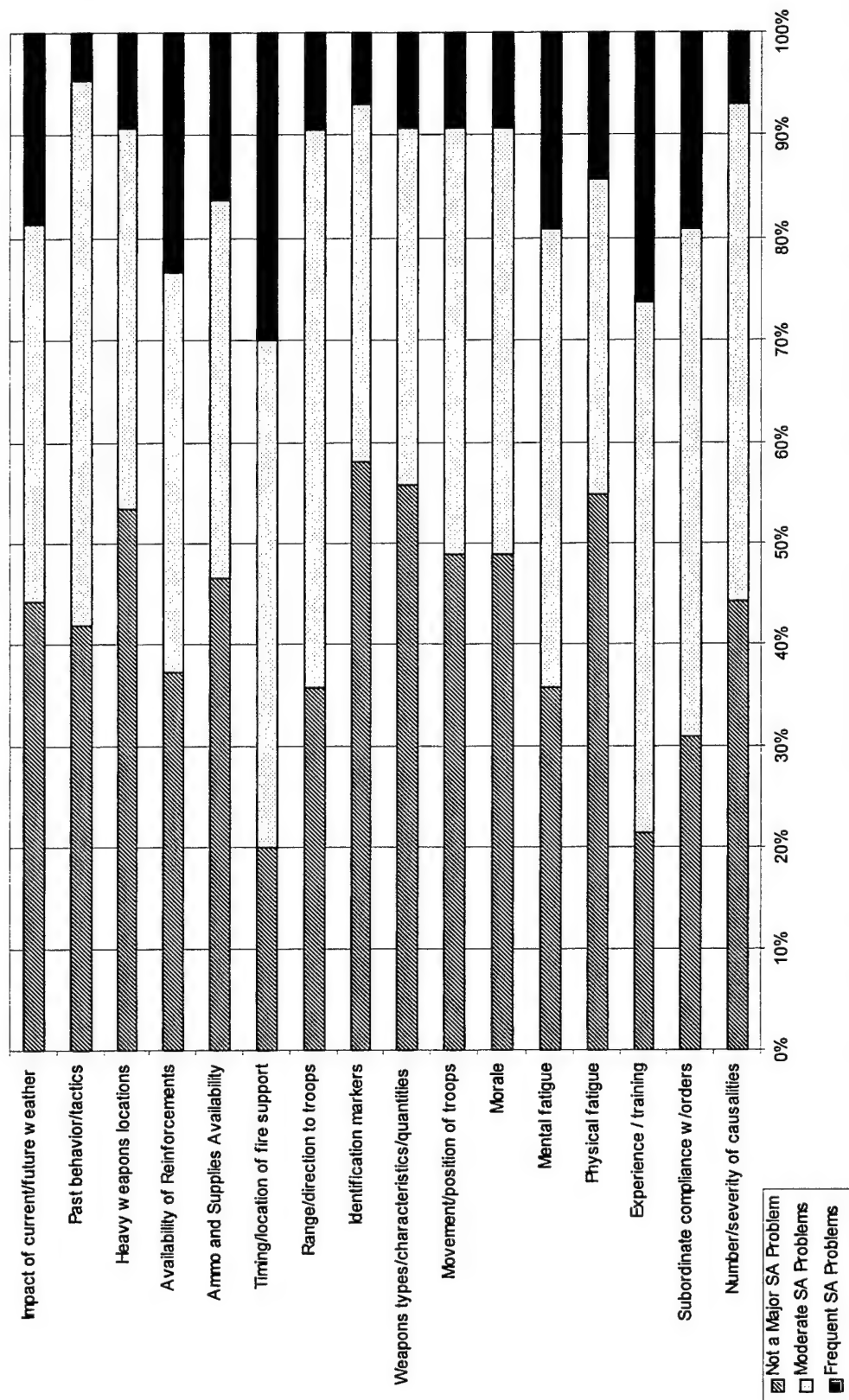


Figure 7. Level 1 SA Questions – Regarding Own Platoon

Factors Influencing Failure to Gather/Detect Critical Information: Not Determining Opposing Forces Combat Readiness Status

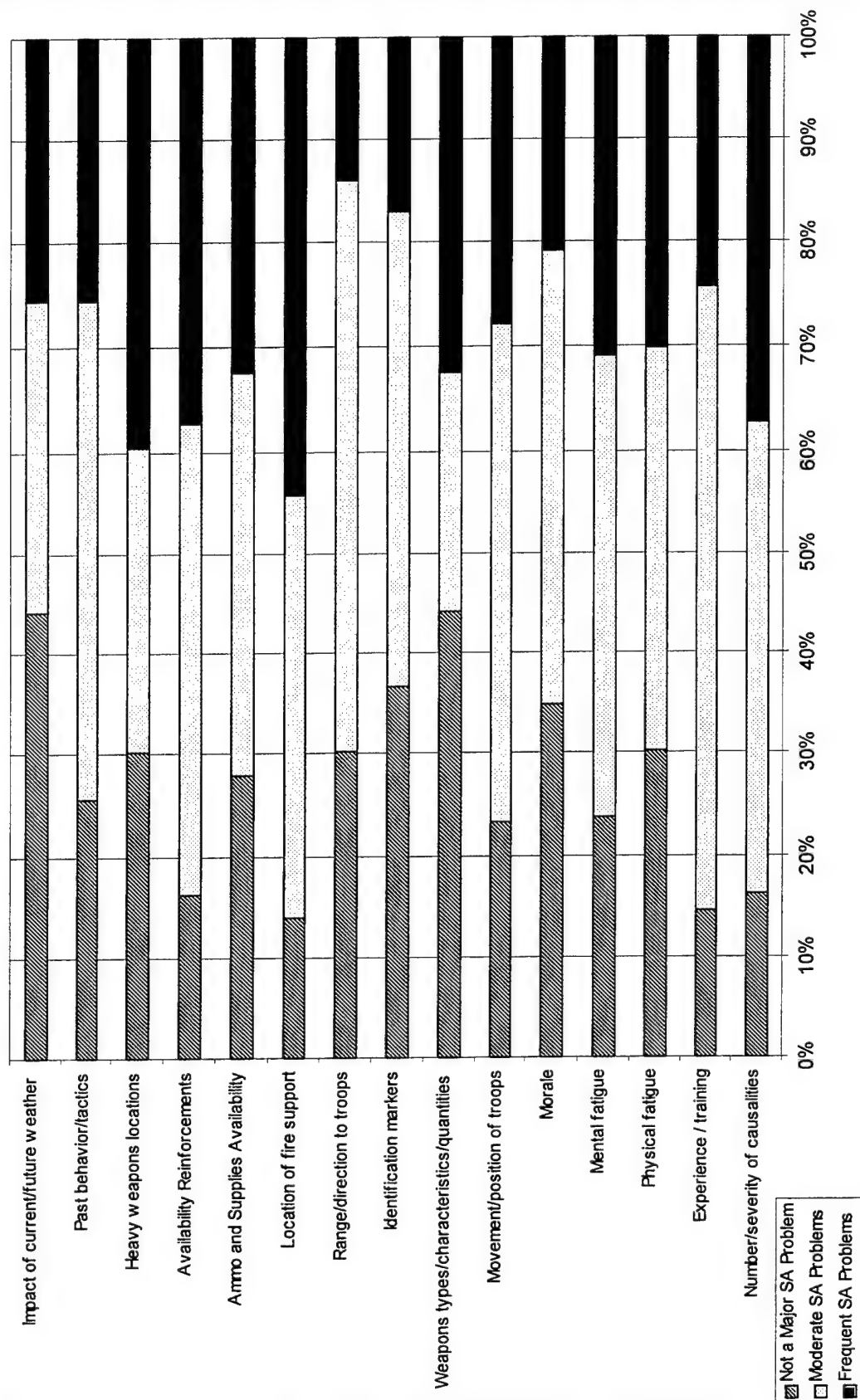


Figure 8. Level 1 SA Questions -- Regarding Opposing Forces

Factors influencing Failure to Comprehend the Situation: General

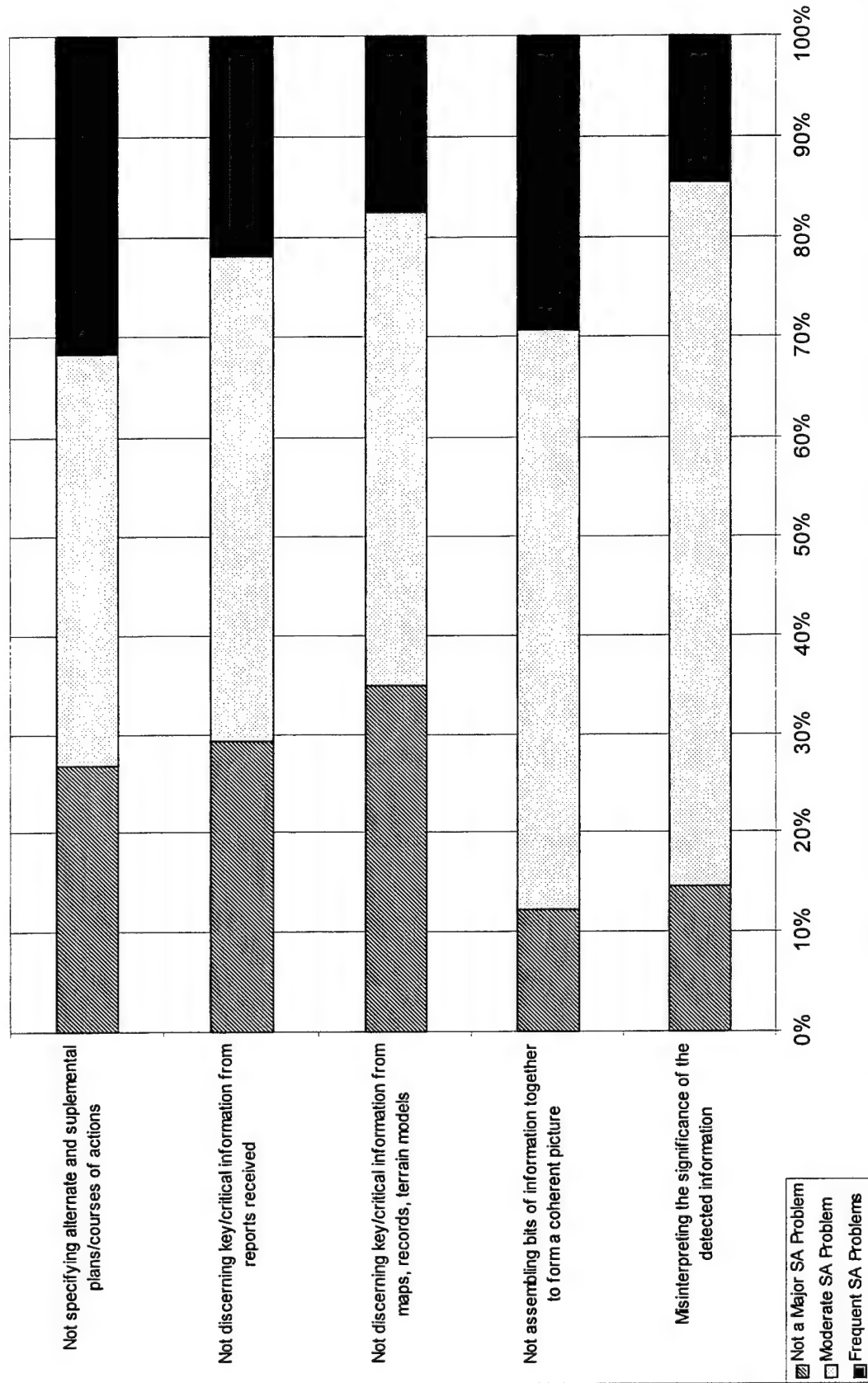


Figure 9. Level 2 SA Questions - General

Factors Influencing Failure to Comprehend the Situation: Lack of Understanding

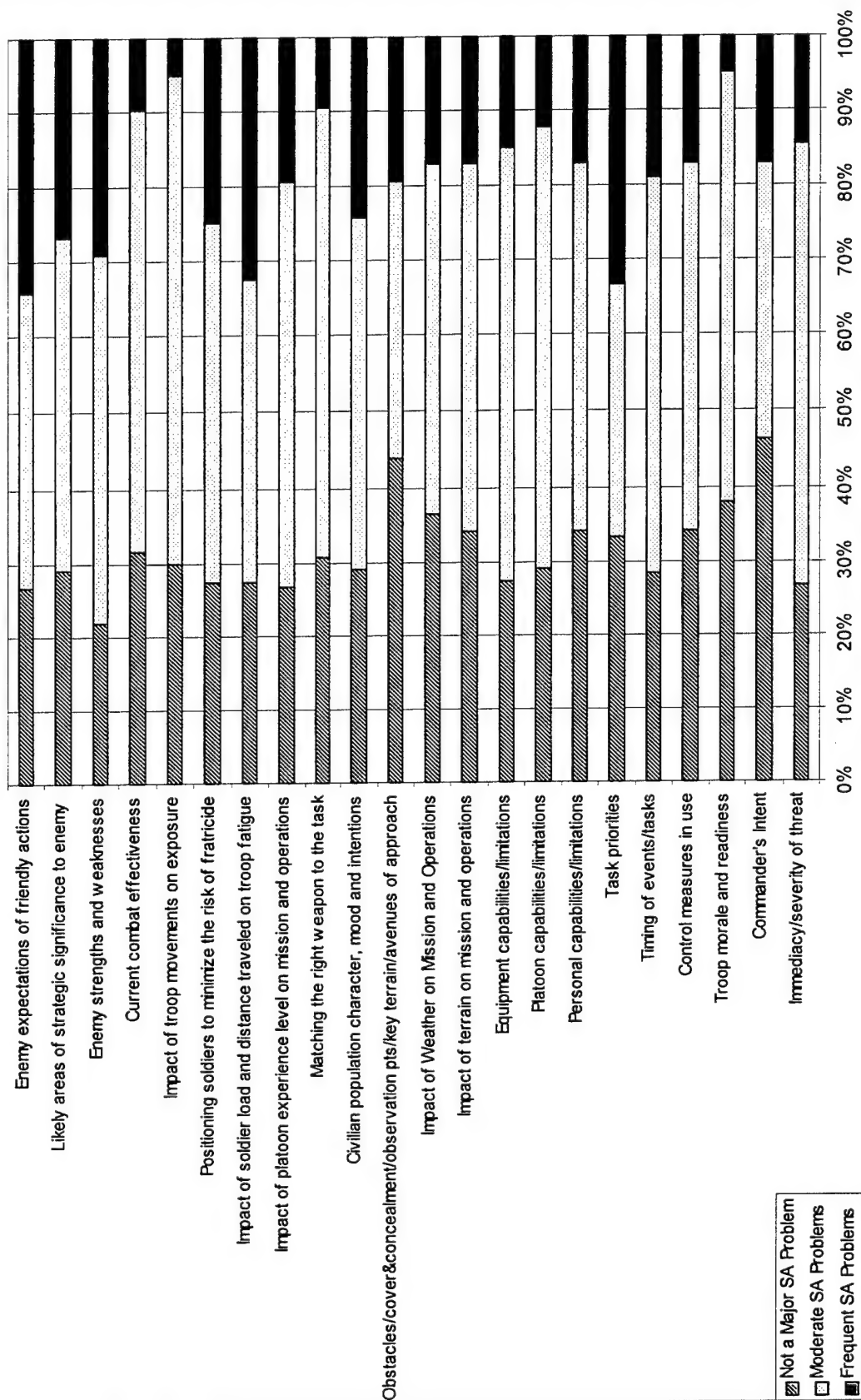


Figure 10. Level 2 SA Questions – Lack of Understanding

Factors Influencing Failure to Project Future Situations

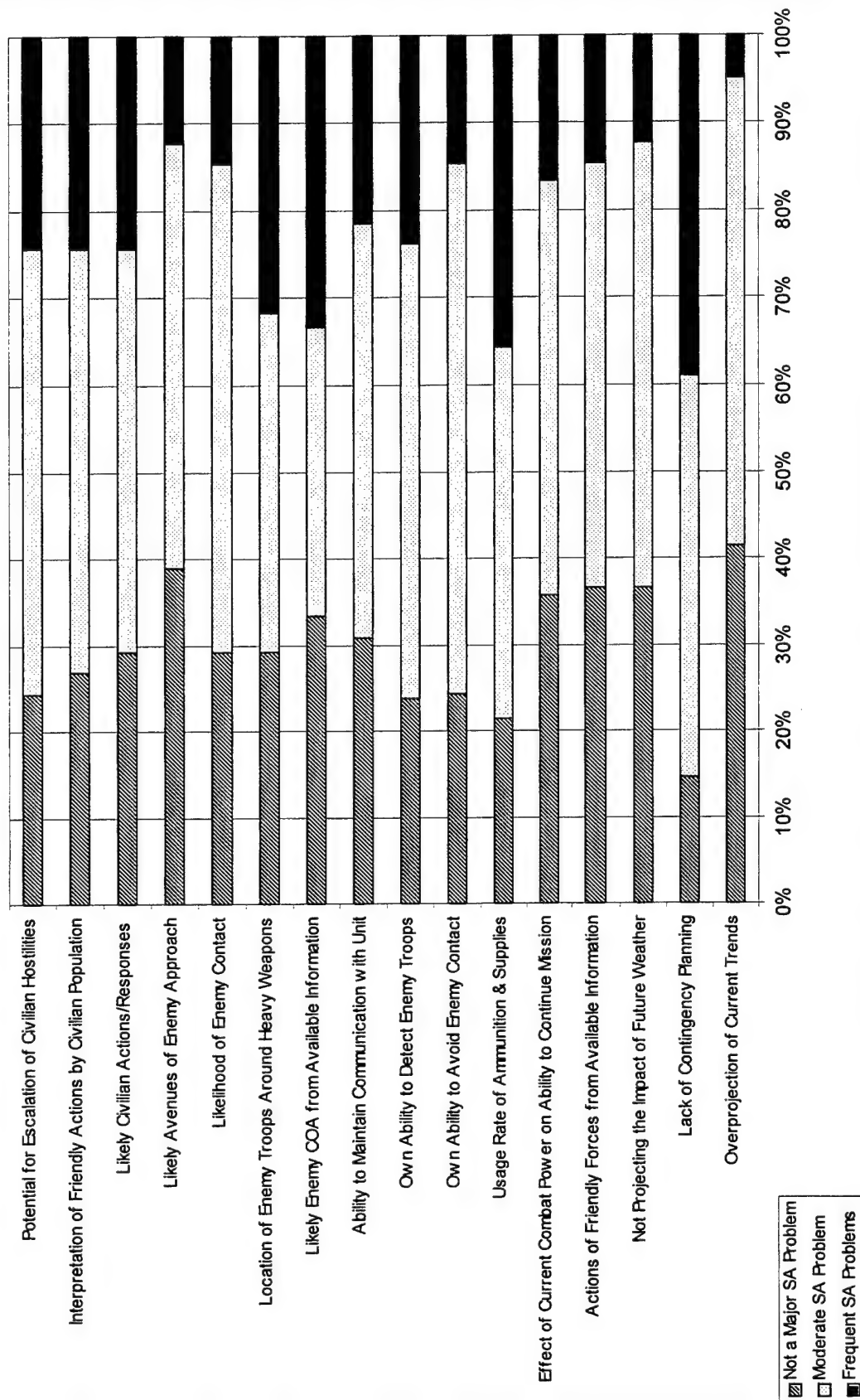


Figure 11. Level 3 SA Questions

Factors Influencing Failure to Effectively Perform Necessary Mission Tasks

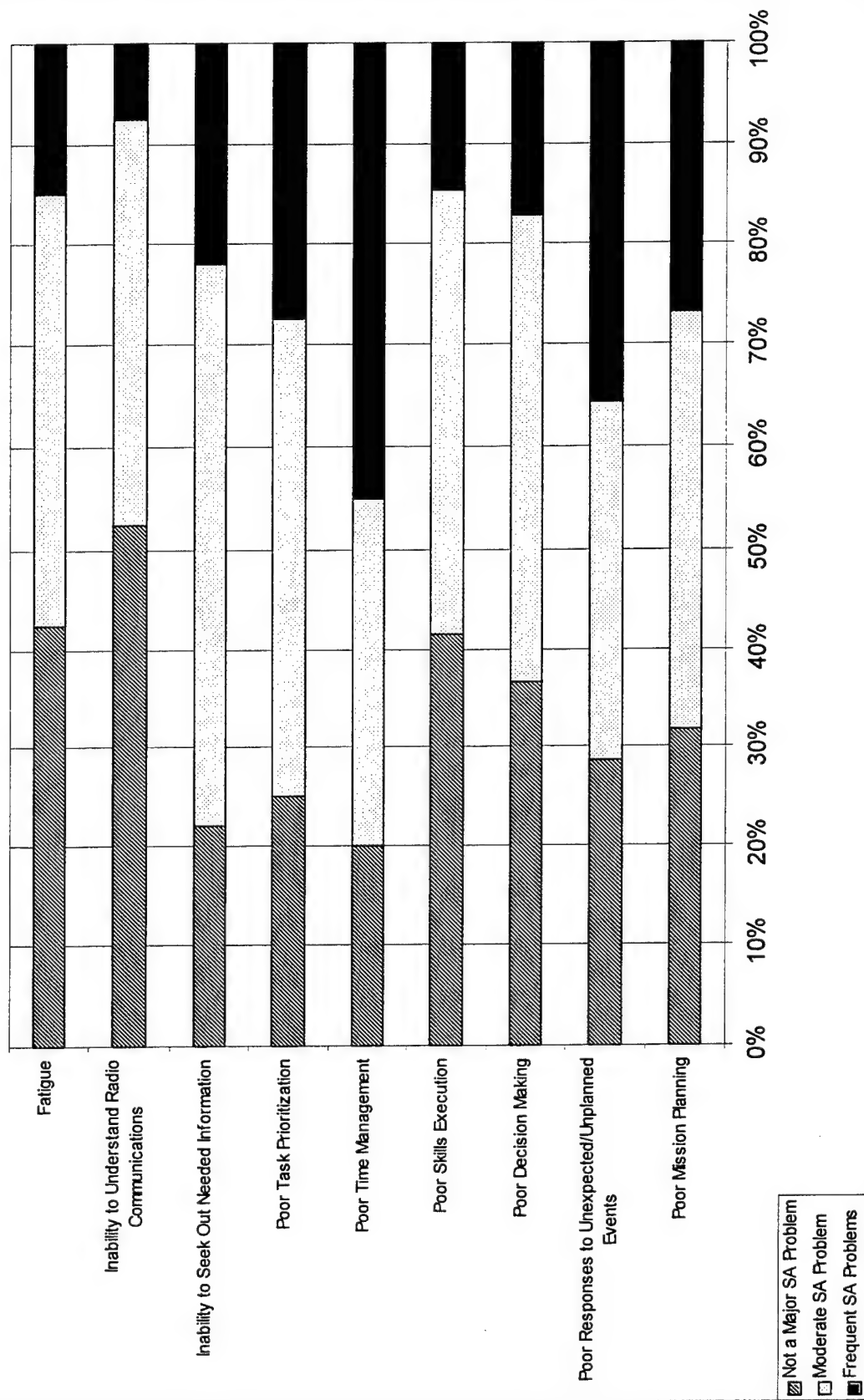


Figure 12. Performance Related Questions

Most significant factors related to SA problems

At the end of each section in the survey, trainers were asked to place a check mark beside the items in that section that they believe present the most serious SA challenges for new platoon leaders. Because there were more items in the Level 1 and 2 SA sections, five check marks were requested here, while three check marks were requested in the sections for Level 3 and Performance items). The results for Level 1 SA questions are shown in Figures 13 through 15. The results for Level 2 SA questions are shown in Figure 16. The results for Level 3 SA questions are shown in Figure 17, and the results for performance questions are shown in Figure 18. Items from each section selected by five or more respondents are shown in Table 6.

While these data share many similarities with the previous data, there are also differences. Again, several communication items were considered among the most problematic issues for Level 1 SA: not requesting information from squad leaders or from the commander, not communicating key information to both squad leaders and the commander, along with not communicating overall situation and commander's intent (CI). In contrast, only one item under determining combat readiness status of opposing forces, specifically, determining experience and training, was widely considered to be one of the most important items. The two areas in detection of information (Level 1 SA) that were of concern to the largest number of respondents were not determining the reliability or timeliness of information and not communicating key information to squad leaders, with both being chosen by seven respondents as one of the most serious SA challenges for new leaders. In terms of comprehension, nine respondents selected not specifying alternate or supplemental COAs, not understanding task priorities, and not understanding enemy expectations of friendly actions as among the most serious problems. In projection of future events, 11 respondents considered projecting the usage rate of ammo and supplies most important, while 10 identified lack of contingency planning. Finally, 11 respondents saw poor responses to unexpected or unplanned events as a serious problem, 13 respondents selected poor task prioritization, and 14 respondents identified poor time management as one of the most serious problems. All of these were also included in the list of items receiving high ratings as a frequent SA problem.

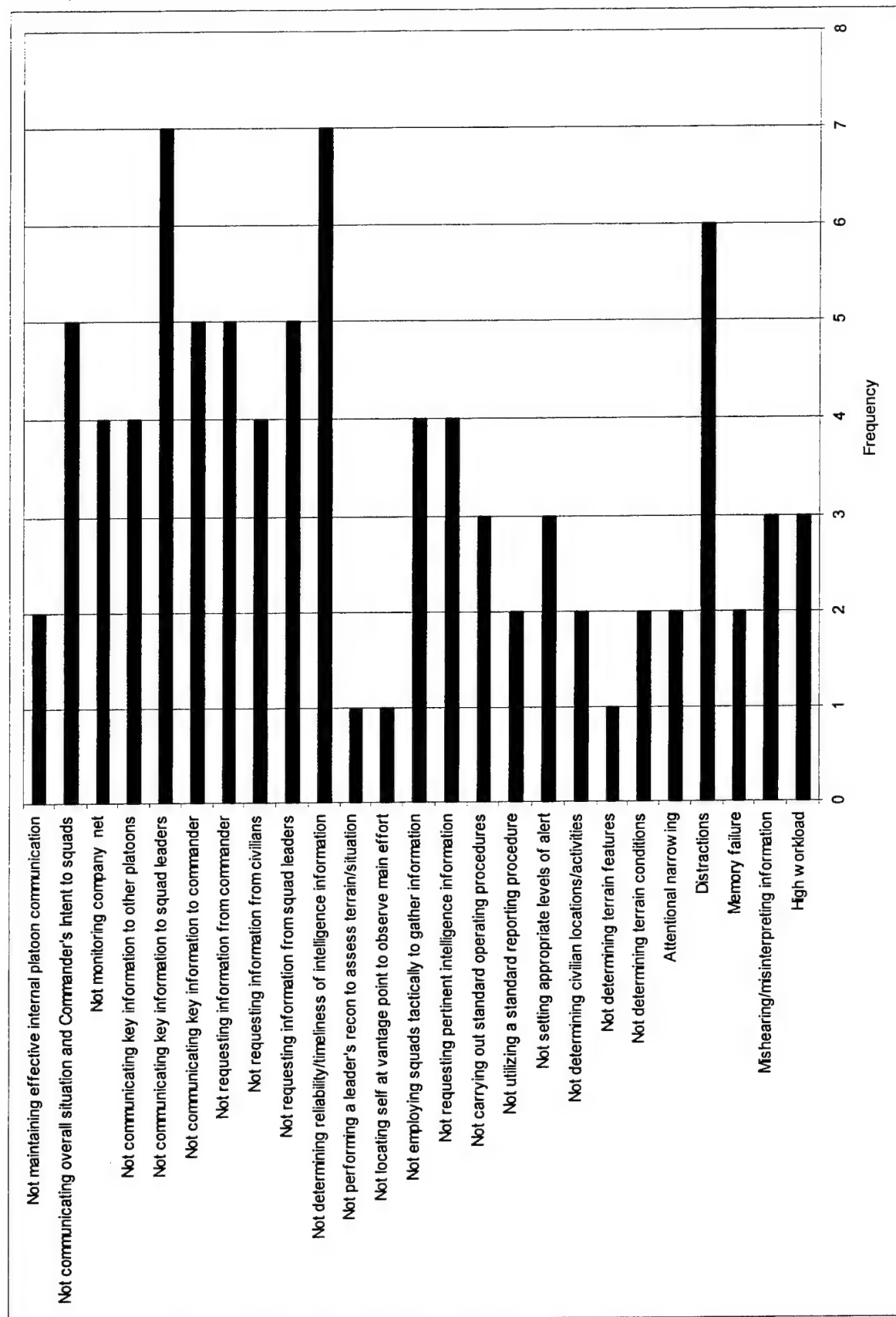


Figure 13. SA Challenges for Level 1 SA questions (questions 1 – 25)

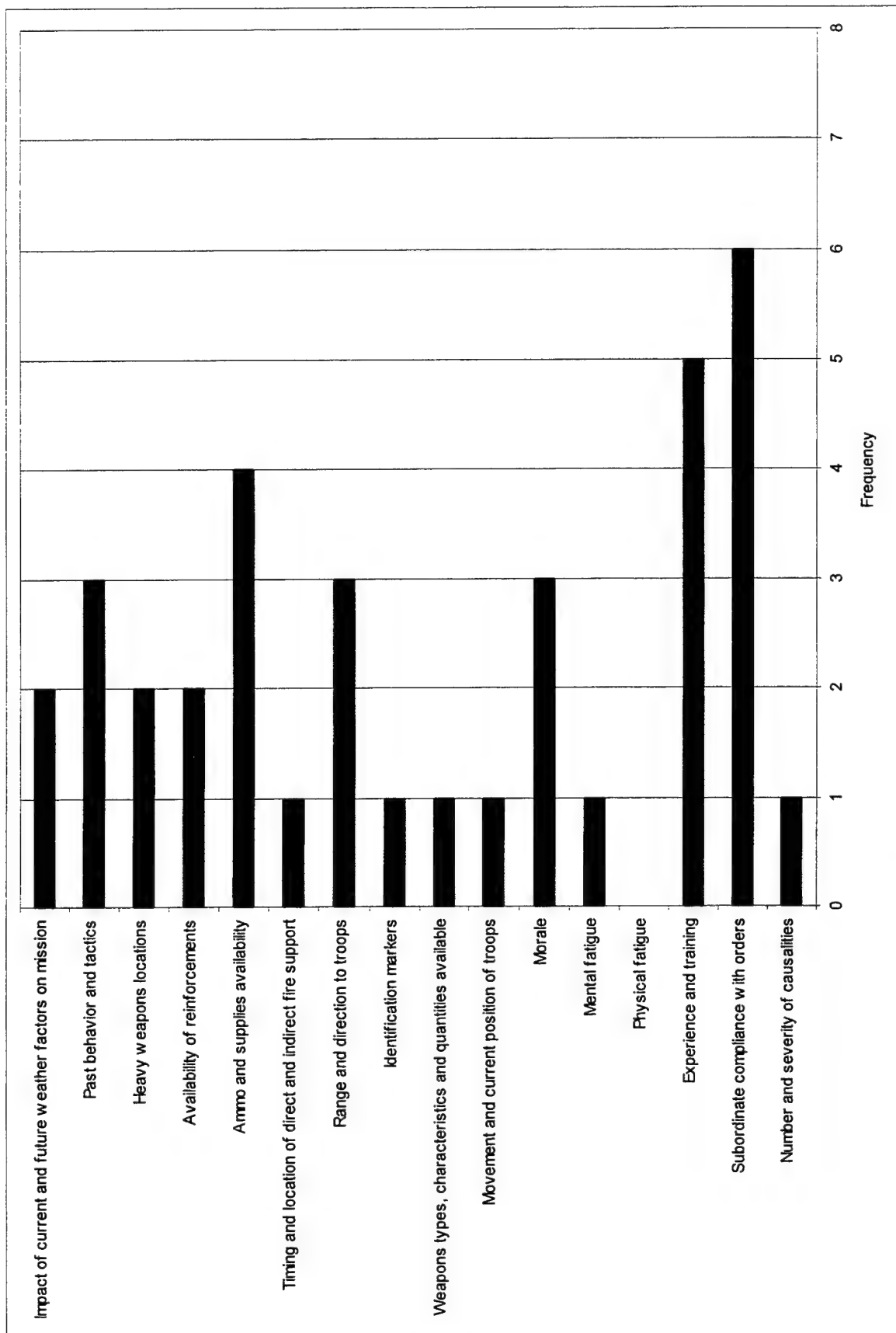


Figure 14. SA Challenges for Level 1 SA questions regarding “Failing to Gather Information regarding Own Platoon”

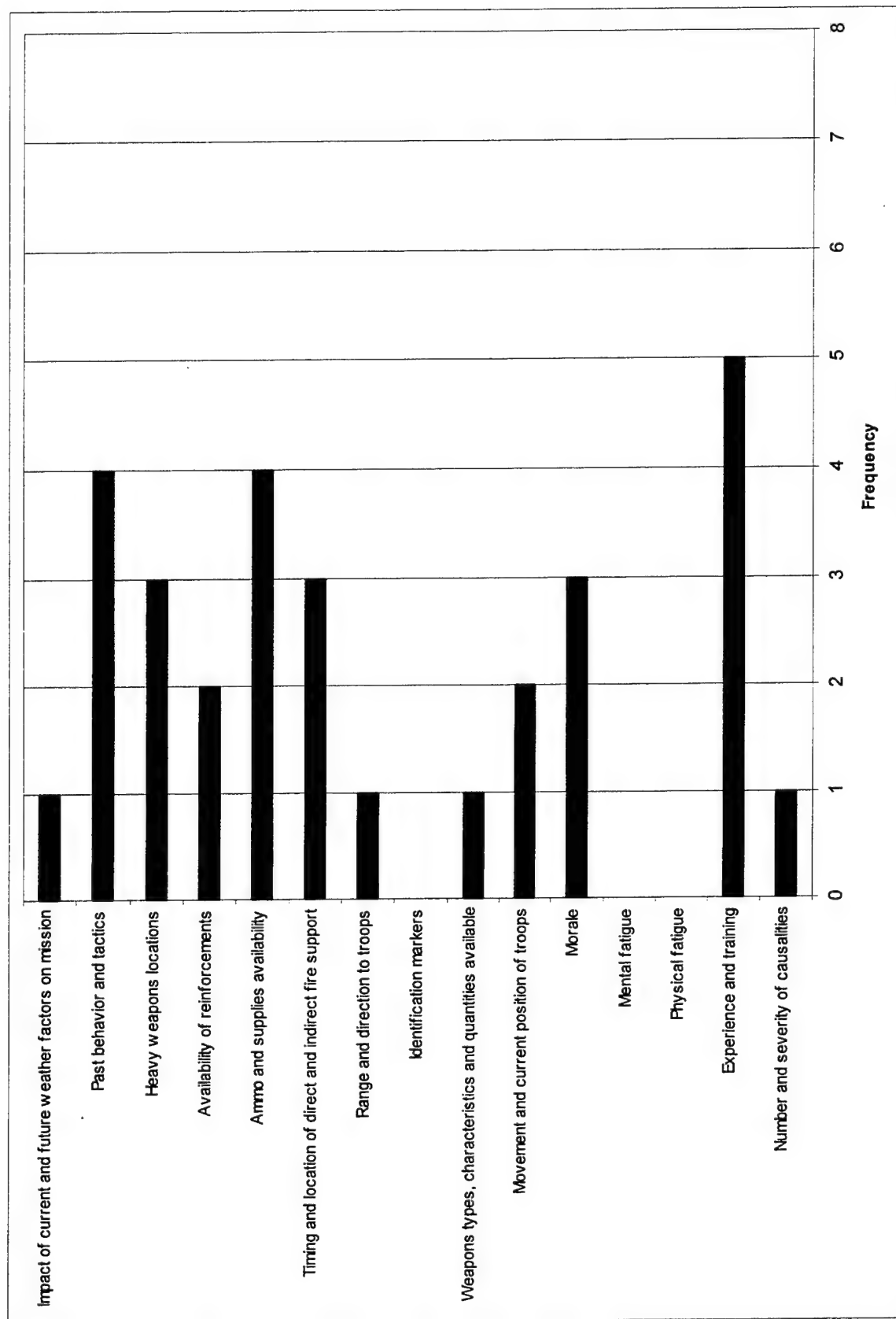


Figure 15. SA Challenges for Level 1 SA questions regarding “Failing to Gather Information regarding Opposing Forces”

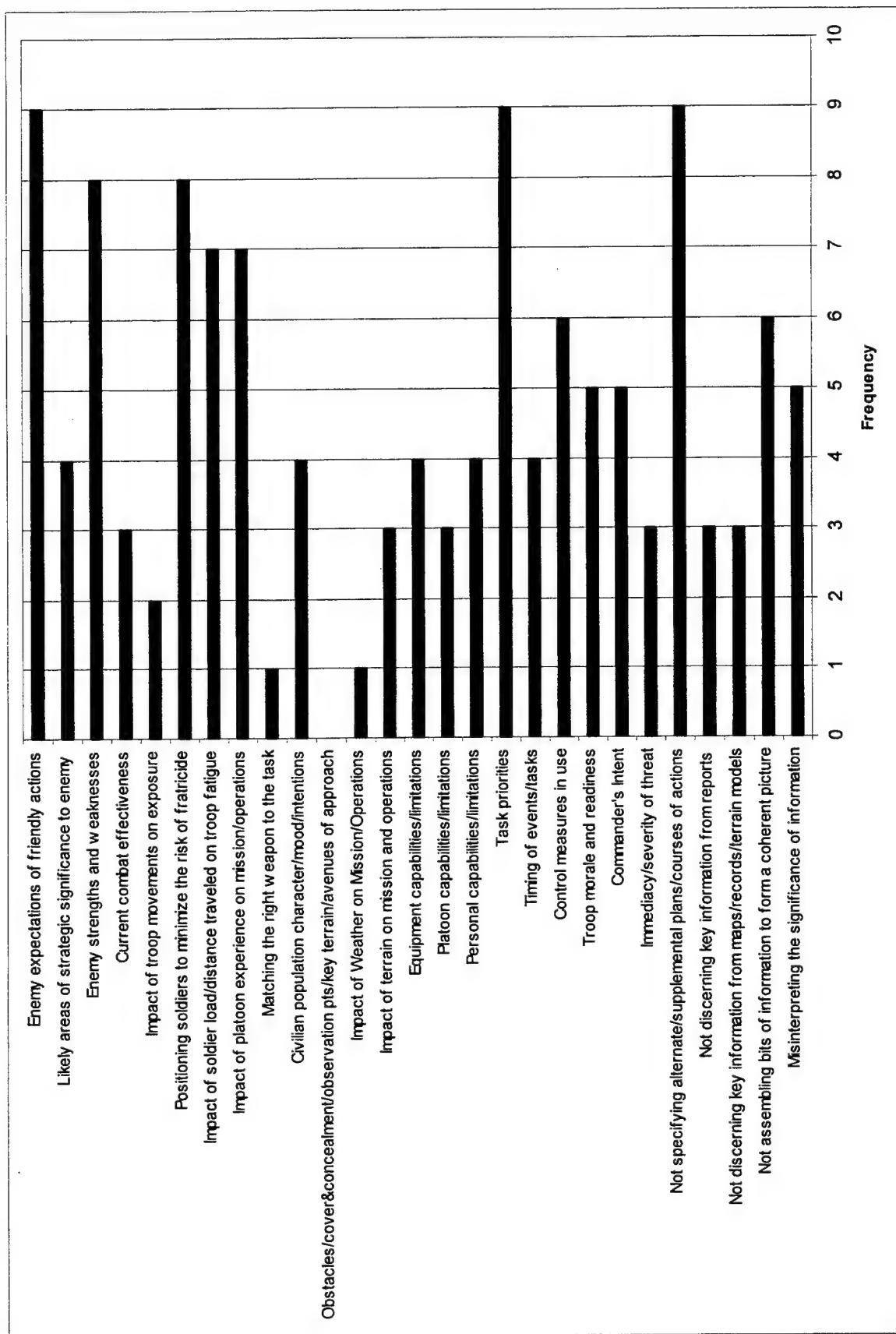


Figure 16. SA Challenges for Level 2 SA questions

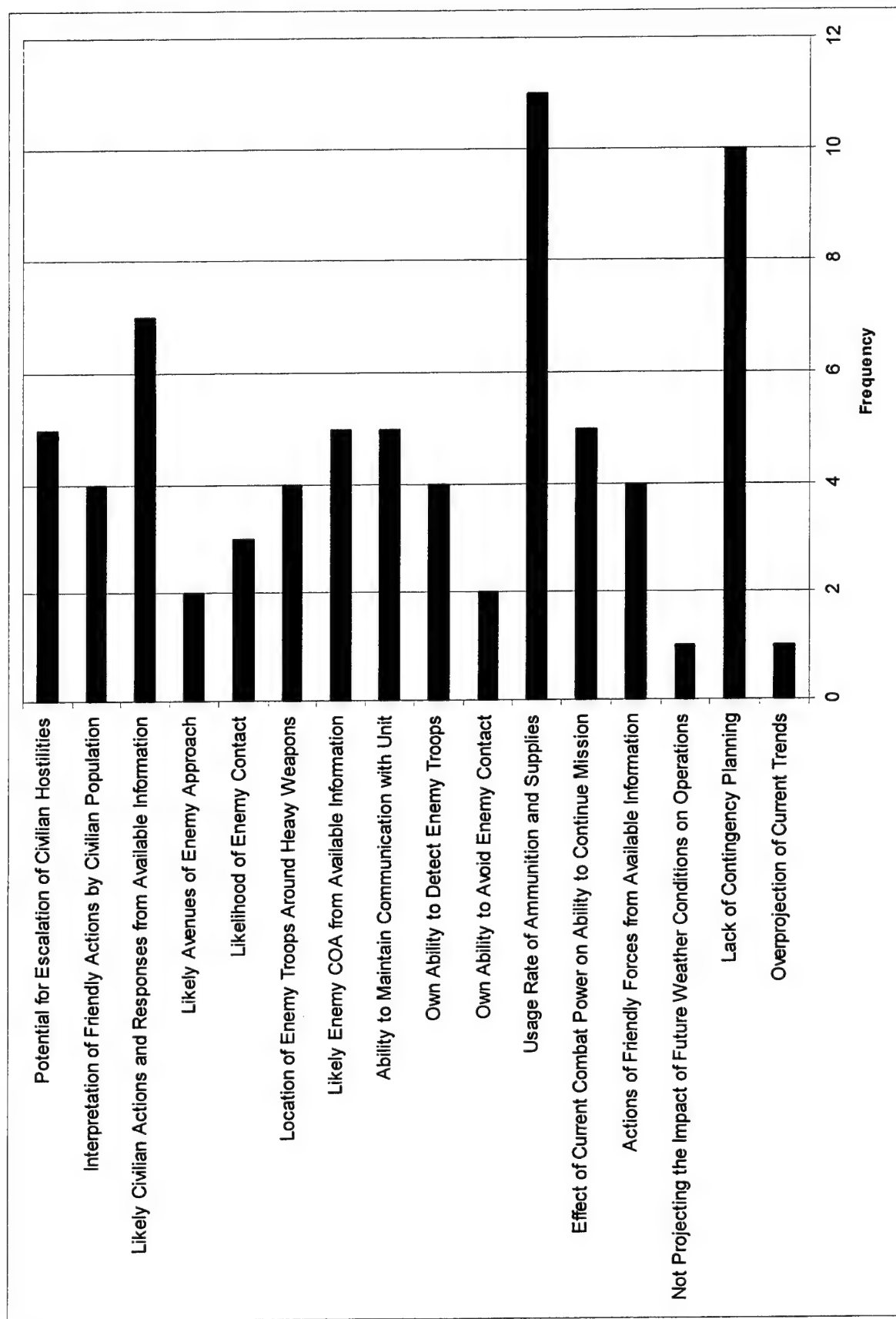


Figure 17. SA Challenges – Level 3 SA questions

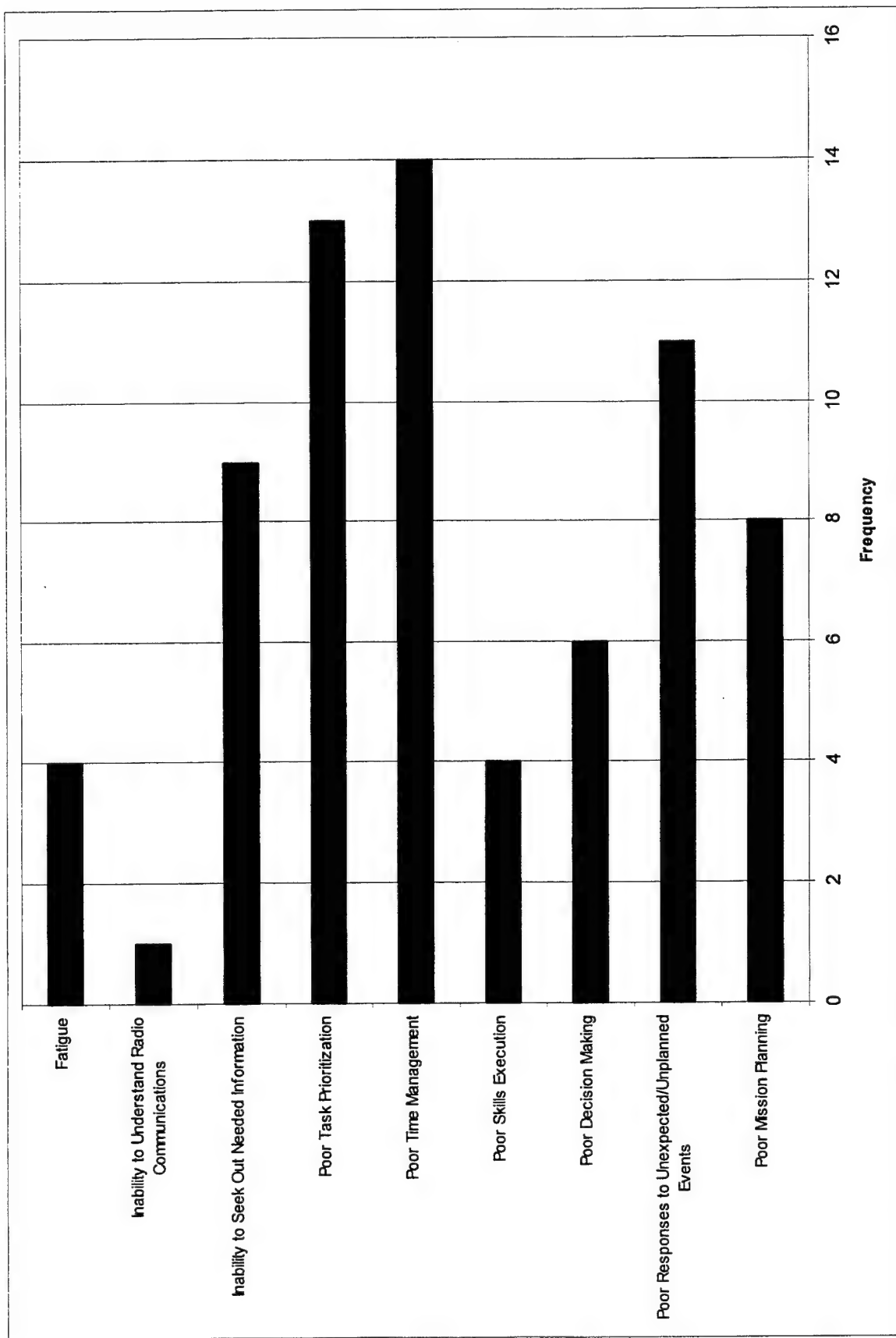


Figure 18. SA Challenges – Performance questions

Table 6. Survey items selected as one of the most serious SA challenges for new leaders by five or more of respondents

Failure to Correctly Gather/Detect the Critical Information in the Situation Due to: (Level 1)	
Question	# of Respondents
Not detecting information due to distractions	6
Not determining reliability/timeliness of intelligence information	7
Not requesting information from squad leaders	5
Not requesting information from commander	5
Not communicating key information to commander	5
Not communicating key information to squad leaders	7
Not communicating overall situation and Commander's Intent to squads	5
Not determining own combat readiness status	
Subordinate compliance with orders	6
Experience and training	5
Not determining combat readiness status of opposing forces	
Experience and training	5
Failure to Comprehend the Situation (even though basic information is detected) due to: (Level 2)	
Misinterpreting the significance of information	5
Not assembling bits of information together to form a coherent picture	6
Not specifying alternate/supplemental plans/courses of action	9
Not developing an understanding of:	
Commander's Intent	5
Troop morale and readiness	5
Control measures in use	6
Task priorities	9
Impact of platoon experience level on mission and operations	7
Impact of soldier load and distance traveled on troop fatigue	7
Positioning soldiers to minimize the risk of fratricide	8
Enemy strengths and weaknesses	8
Enemy expectations of friendly actions	9
Failure to Project the Future Situation (though current situation is understood) due to: (Level 3)	
Lack of contingency planning	10
Failure to project the following:	
Effect of current combat power on ability to continue mission	5
Usage rate of ammunition and supplies	11
Ability to maintain communication with unit	5
Likely enemy COA from available information	5
Likely civilian actions and responses from available information	7
Potential for escalation of civilian hostilities	5
Failure to Effectively Perform the Necessary Mission Tasks Due to: (Performance)	
Poor mission planning	8
Poor responses to unexpected/unplanned events	11
Poor decision making	6
Poor time management	14
Poor task prioritization	13
Inability to seek out needed information	9

Analysis of Differences Between Respondents

Instructor Rank. A Chi-Square Test for Differences in Probabilities (two-sided test, = .05) was performed to investigate potential relationships between response patterns between officer and enlisted personnel. Since this manner of analysis resulted in numerous individual tests, the possibility exists that some of the items reflected statistical significance merely by

chance. However, given that this study is exploratory in nature and no strong claims are being asserted from the results, the items with significance can be viewed as issues particularly relevant for further study, thereby warranting added attention. The results of the analysis are shown in Appendix B. From this analysis, 25 questions indicated that officers and enlisted personnel answered the questions differently. Table 7 shows the direction of difference for these results, while Figures B-1 through B-22 in Appendix B show the pattern of these responses.

Table 7. Survey items with significant differences between officer and enlisted ratings

Level	Question	Higher
1	Not setting appropriate levels of alert	Officer
	Not carrying out standard operating procedures	Officer
	Not determining reliability/timeliness of intelligence information	Officer
	Not communicating overall situation and Commander's Intent to squads	Officer
	Mental fatigue – Own troops	Enlisted
	Movement and current position of troops – Own troops	Enlisted
	Mental fatigue - OPFOR	Officer
	Movement and current position of troops - OPFOR	Officer
	Identification markers - OPFOR	Enlisted
	Impact of current and future weather factors on mission	Enlisted
	Misinterpreting the significance of the detected information	Officer
	Not discerning key/critical information from reports received	Officer
2	Immediacy/severity of threat	Enlisted
	Commander's Intent	Officer
	Timing of events/tasks	Enlisted
	Positioning soldiers to minimize the risk of fratricide	Officer
	Enemy strengths and weaknesses	Officer
	Likely areas of strategic significance to enemy	Officer
	Enemy expectations of friendly actions	Officer
	Actions of friendly forces from available information	Officer
3	Likely avenues of enemy approach	Officer
	Inability to seek out needed information	Officer
Performance		

Note. Higher indicates the item was of greater concern to the listed group.

In most cases where there were differences between officers' ratings and those of enlisted personnel, officers indicated higher levels of concern about the SA of new platoon leaders. This may reflect the different nature of the training performed by officers and enlisted personnel. While both have the responsibility of training new platoon leaders, it is likely that the training emphases are different for the different echelons of trainers. The items, which were rated higher by enlisted men, include mental fatigue and position of own troops, impact of weather conditions on mission, identification markers of OPFOR, and immediacy and severity of threat. Knowledge of these items is crucial to the success and safety of the mission, a significant concern to enlisted men since they often operate in close quarters with the platoon leader as members of the same platoon. It is also possible that, because all of the subject matter experts used to develop the SA requirements analysis and this survey were officers, we inadvertently developed an instrument that taps more fully into the concerns of officers.

Instructor Experience. A second Chi-Square Test for Differences in Probabilities (two-sided test, $\alpha = .05$) was performed to determine if response patterns were associated with the respondents' experience instructing new platoon leaders. As before, the numerous tests required by this type of analysis allows for the possibility that some of the items will reflect statistical significance merely by chance, but again, this study is exploratory and this analysis highlights items that provide a starting point for further analyses.

The respondents were categorized into one of two categories: those who primarily trained new platoon leaders who had less than 12 months at their current rank (time in grade) and those who primarily trained new platoon leaders who had more than 12 months time in grade. Thirty-four surveys were categorized using this classification; the other nine surveys could not be categorized in this manner either because this question was not answered or because the answers were the same across the categories and thus were not mutually exclusive. The results of the analysis are shown in Appendix C. From this analysis, 14 questions indicated that experience influenced the manner in which the respondents answered the questions. Figures C-1 through C-14 show the pattern of these responses.

A different response pattern was found between the ratings of those trainers who primarily train platoon leaders with less than 12 months experience and those who train leaders with more than 12 months experience. There are minor differences on some items in the ratings of frequent SA problems and in the ratings of not a major SA problem, but for every item that showed a difference in these two groups, trainers in the more experienced group had higher ratings for the moderate SA problems category. A likely explanation for this is that these individuals are training platoon leaders who already have some experience, therefore they have already improved their SA skills in these areas to some extent, and so these items are only considered moderate SA problem areas.

Discussion

Trainers indicated areas across all three levels of SA, and in a more general performance category, where new platoon leaders demonstrate problems with SA. For Level 1 SA, perception, trainers indicated the most consistent problems in the areas of communication and knowledge about the opposing force. This problem carries over into higher levels of SA, as failure to understand the implications of information about the enemy is also indicated as a major problem for Level 2 SA. This supports the finding that less experienced officers tend to focus more on friendly troops than enemy troops (Strater et al., 2001), although the survey indicates that this is a problem across all three levels of SA.

In addition to these two areas, several other areas of concern were identified. Time management received the highest number of "frequent SA problems for new platoon leaders" ratings of all the items on the survey. Along with this, task prioritization was indicated as a major SA problem for new leaders at both the level of understanding what task priorities should be, and at performance in task prioritization. Poor planning was also identified as a major area of concern, resulting in such Level 2 problems as not specifying alternate plans/COAs, in Level 3 problems as lack of contingency planning, and in the performance section as both poor mission planning and poor responses to unexpected/unplanned events. These findings can be summarized as:

- Level 1
 - Communication
 - Not requesting information from squads leaders and commander
 - Not communicating key information to squad leaders, commander and other platoons
 - Not monitoring company net
 - Not communicating overall situation to squads
 - Opposing Force
 - Casualties
 - Mental and physical fatigue
 - Movement and position of troops
 - Weapons, fire support, ammunition, heavy weapons
 - Reinforcements and supplies
 - Past behavior and tactics
- Level 2
 - Not forming a coherent picture
 - Not specifying alternate COAs
 - Task priorities
 - Opposing Force
 - Strengths and weaknesses
 - Likely areas of strategic significance
 - Expectations of friendly actions
- Level 3
 - Lack of contingency planning
 - Usage rate of ammunition and supplies
 - Opposing Force
 - Likely enemy COA
 - Location of troops around heavy weapons
- Performance
 - Poor planning/contingency planning
 - Poor time management/task prioritization

These findings are well in line with prior SA research indicating areas where SA differs between either more experienced or better performing individuals and less experienced individuals (Brezovic et al., 1987; Klein & Calderwood, 1996; Serfaty et al., 1997; Strater et al., 2001). This convergence provides a strong indication that these findings can be exploited to develop training programs with a very high probability of improving not only SA in these areas, but also performance.

Conclusions and Recommendations

In conclusion, new Infantry platoon leaders, relatively inexperienced officers, have difficulty in building and maintaining an accurate picture of the situation in a number of areas. The most frequent problems associated with poor SA in this group can be summarized to include:

1. Problems with basic skills that contribute to not gathering needed information
 - a. Not carrying out standard operating procedures (SOPs)

- b. Not utilizing standard reporting procedures (SRPs)
- 2. Problems in perceiving key information in the situation
 - a. Not determining terrain
 - b. Mishearing or misinterpreting information
 - c. Attentional narrowing
 - d. Poor intelligence gathering
 - e. Not determining the reliability and timeliness of information
 - f. Not employing squads tactically to gather needed information
 - g. Not requesting pertinent information from others
- 3. Failure to communicate
 - a. Overall situation and commander's intent to squads
 - b. Not monitoring net
 - c. Not communicating key info to other platoons, squads, commander
 - d. Not requesting information from commander, civilians, squads

Particular elements of the situation which tend to get neglected by new platoon leaders or which they tend not to take into account (Level 1 SA) includes information on:

- 1. Status of own troops
 - a. Impact of current or future weather on troops
 - b. Reinforcement availability/status
 - c. Timing/location of fire support
 - d. Mental fatigue of troops
 - e. Experience/training of troops
 - f. Subordinate compliance with orders
- 2. Status of opposing forces
 - a. Impact of current or future weather on troops
 - b. Reinforcement availability/status
 - c. Timing/location of fire support
 - d. Mental fatigue of troops
 - e. Experience/training of troops
 - f. Subordinate compliance with orders
 - g. Past behavior/tactics
 - h. Heavy weapons locations
 - i. Ammo/supplies availability
 - j. Weapons types, characteristics, quantities
 - k. Movement/position of troops
 - l. Morale
 - m. Physical fatigue
 - n. Number/severity of casualties

In addition to failing to consider this key information, new platoon leaders are also noted to have trouble fully understanding either the information or the relevance of the information that they do receive (Level 2 SA). This includes a failure to comprehend:

- 1. Developing alternate and supplemental plans/courses of action
- 2. Discerning key/critical information from reports
- 3. Discerning key/critical information from maps, records, terrain models
- 4. Assembling bits of information together to form coherent picture
- 5. Not developing an understanding of obstacles, cover/concealment, observation points, terrain, and avenues of approach
- 6. Task priorities

7. Timing of events/tasks
8. Enemy expectations of friendly actions
9. Likely areas of strategic significance to enemy
10. Enemy strengths/weaknesses
11. Positioning soldiers to minimize fratricide
12. Impact of load and distance on fatigue
13. Impact of experience level on mission and operations
14. Civilian population character, mood and intentions

Finally, new platoon leaders were found to have problems with the highest level of SA, projecting likely future events based on their understanding of the current situation. This includes a failure to project:

1. Potential of escalation of civilian hostilities
2. Interpretation of friendly actions by civilians
3. Likely civilian actions/responses
4. Location of enemy troops around heavy weaponry
5. Likely enemy COA from available information
6. Ability to maintain communication with unit
7. Own ability to detect enemy troops
8. Own ability to avoid enemy contact
9. Usage rate of ammunition and supplies
10. Lack of contingency planning

This characterization of the areas in which new platoon leaders have problems with developing and maintaining SA points to several recommendations for methods in which SA might be enhanced through focused training programs that go beyond what they experience in today's exercises. These approaches address either the development of important knowledge bases or key skills that are needed for SA in the Infantry arena.

Schema Training

One of the most important factors underlying the development of good SA is the presence of mental models and schemata of prototypical situations (Endsley, 1988, 1995). These schemata provide the background through which warfighters are able to rapidly organize and interpret the vast amounts of information that they encounter. They provide a crucial mental construct directing how individuals should allocate their attention and which cues are critical, signaling an important 'different' class of situation (e.g. a movement in enemy position). Schemata provide the framework that allows warfighters to rapidly assess, on the basis of incomplete information, what is important, and what is not.

Novice platoon leaders suffer greatly from not having these mental models and schemata. They are quickly overwhelmed by information, are slow to grasp which information is important, and where to look for important follow up information. Experienced platoon leaders can do this almost automatically. Their schemata and mental models form one of the most important knowledge base foundations that allow for high levels of SA in demanding combat environments. Unfortunately, to date, developing accurate and viable mental models has required trial and error experience in actual or training combat situations. With budgetary and time constraints a reality of the Infantry training environment, these individuals have a limited number of opportunities to participate in these schema building opportunities. It can take many years and

many field exercises to develop robust mental models of how the combat world works (including friendly and enemy operations) along with a repertoire of important schemata for recognizing and classifying prototypical states of that world. Structured training should be provided that allows platoon leaders to develop better mental models and schemata prior to exercises which they can then further develop and use in their field based exercises and actual combat experience.

It is well known that experts in some domains fail to demonstrate improved judgements when compared to novices (Ayton, 1992), while in other domain experts are clearly superior in their assessments than novices (Brezovic et al., 1987; Klein, 1995; Khaneman, Slovic, & Tversky, 1982). One significant difference between the two groups is that domains that provide the opportunity for significant amounts of practice and feedback yield experts whose judgments are significantly superior to those of novices (Shanteau, 1992). This type of training would provide a high number of experiences, pointing out critical cues and providing indications of higher levels of SA (comprehension and projection), associated with each template. It would also provide opportunities for feedback and improvement. This training could greatly enhance the ability of new platoon leaders to identify critical information in situations they encounter and from that information develop the higher level situational understanding that is demanded.

Communications Training

Communications problems are identified as a significant issue underlying poor SA in inexperienced platoon leaders. Because a large portion of SA comes across communications channels in this environment (either direct verbal, non-verbal or radio communications), this area is a key skill area for improving SA in platoon leaders and for all warfighters. This research shows that the officers often were not communicating key information because they assumed they knew what was going on, or that the information did not need to be passed on.

Most current communications programs focus on communications protocols and syntax, which are certainly important. Additional communications training that would help to further enhance SA would be slightly different, and complementary to those efforts. Such training would focus on leading the warfighter to consider multiple factors in determining *what* to communicate, along with *when*, and to *whom* information should be conveyed. Often the problem is not that the individual does not know how to communicate (i.e. knowledge of the proper reporting protocol), but does not always realize there is a benefit to communicating or requesting certain information (e.g. "I didn't realize they needed to know that" or "I didn't know that was important", or "I didn't think to ask that").

Task Management and Prioritization

Better skills in assessing the time requirements and prioritization for different tasks are also needed to enhance SA. As SA is very dynamic in nature, timing and prioritization of events and tasks are essential elements of comprehension and projection, the highest levels of SA. Many SA problems can occur if individuals are unable to properly prioritize tasks based on events and determine the timing requirements associated with them (e.g. "how much time do I have until my troops will be in place?" "how long will it take for reserve units to arrive?" "which tasks can I accomplish in the allotted time period and which tasks are most important in this situation?").

Structured training on task management and prioritization would also be useful in improving SA in new platoon leaders.

Contingency Planning

A major strategy for improving SA is to train warfighters in the importance of contingency planning and to provide them with some of the information that should be considered when making contingency plans. Contingency planning is highly related to SA. It is a skill clearly linked to Level 3 SA (projection of the future). Good warfighters are able to use low workload periods to anticipate and plan for contingencies, allowing them to be proactive rather than reactive if those future events occur (Amalberti & Deblon, 1992 ; Endsley, 1995). Contingency planning greatly contributes to high levels of SA projection (the highest level of SA) and the ability to quickly detect and comprehend events. Those who do not actively engage in contingency planning are far more likely to be overloaded by events in high workload periods. While some experienced officers and soldiers have learned to do this naturally, many do not actively employ this skill. By training platoon leaders in the importance of contingency plans and providing them with specific problems to work through in the training, the contingency planning training module seeks to increase the frequency of contingency planning and situation projection in platoon leaders.

In conclusion, SA in the environment of the Infantry warfighter poses many challenges for SA. Much needed information is often uncertain or unknown. Harsh environmental conditions, fatigue and stress can act to strain abilities needed for good SA. Dealing one on one with civilians and acting in urban terrain can be fraught with ambiguity. The cognitive skills and knowledge that underlies good SA can be very difficult to develop with limited opportunities to experience and practice within this problem space. Focused training programs that specifically seek to address key areas needed for SA may be very beneficial and should be further explored.

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Appendix A: Platoon Leader Survey Instrument
Infantry Instructor Survey
On Platoon Leader Situation Awareness
PT No. 60-33

With the support of the Army Research Institute (ARI), SA Technologies, Inc. is obtaining information to develop methods for training to improve situation awareness (SA) in platoon leaders. Your responses to the attached survey will assist in this effort. Participation in this survey is completely voluntary and your responses will be kept confidential by ARI and SA Technologies.

**Please return completed survey to Laura Strater (address at bottom)
by March 15, 2001.**

Thank you for your participation in this survey.

Defining Situation Awareness

Maintaining a high level of SA is one of the most critical and challenging features of a platoon leader's job. Time and effort is required to develop SA and keep it up to date in a rapidly changing environment. While many military sources define SA as knowing where you are, where your buddies are and where the enemy is, complete SA is actually much more. A general definition describes SA as **"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future."** SA, then, consists of three levels. First the platoon leader perceives the data; next integrating it into a complete picture, including understanding how the information relates to his goals. Finally, he projects the information into the near future to identify likely outcomes and facilitate decision-making. The attached survey will look at potential problems at all three levels of SA.

Combat Instruction Experience

Instructions: Fill in the blank or circle the number that best matches your experience level.

Total Years of Active Duty Service: <6 6-11 >12 Your current Rank: _____

Your total years of combat instruction experience in the following areas:

Officer Basic:	<6	6-11	>12	MOUT:	<6	6-11	>12
Ranger School:	<6	6-11	>12	Other (please specify):			
Airborne School:	<6	6-11	>12	_____:	<6	6-11	>12
Air Assault:	<6	6-11	>12	_____:	<6	6-11	>12
Special Forces:	<6	6-11	>12				

Please estimate the number of platoon leaders you have instructed with the following time in grade:

Less than 12 MOS _____ 12-24 MOS _____ More than 24 MOS _____

Infantry Instructor Survey

On Platoon Leader Situation Awareness

Instructions: Circle the number that indicates the degree to which you perceive each is a problem for new platoon leaders.

Rating Scale

- 1 Not a major SA problem for new platoon leaders
- 2 Moderate SA problems for new platoon leaders
- 3 Frequent SA problems for new platoon leaders

Circle Response

A. Failure to correctly GATHER/DETECT the critical information in the situation due to:

- | | |
|--|-------|
| Not detecting information due to high workload | 1 2 3 |
| Mishearing or misinterpreting information | 1 2 3 |
| Memory failure (e.g., forgetting radio frequency, call signs, passwords) | 1 2 3 |
| Not detecting information due to distractions | 1 2 3 |
| Not detecting information due to attentional narrowing
(e.g., fixation on one aspect of the environment or source of information) | 1 2 3 |
| | |
| Not determining terrain conditions (e.g. rubble, mud) | 1 2 3 |
| Not determining significant terrain features (e.g. obstacles, cover and concealment) | 1 2 3 |
| Not determining civilian locations and activities | 1 2 3 |
| Not setting appropriate levels of alert | 1 2 3 |
| Not utilizing a standard reporting procedure | 1 2 3 |
| Not carrying out standard operating procedures | 1 2 3 |
| | |
| Poor Intelligence information due to: | |
| Not requesting pertinent intelligence information | 1 2 3 |
| Not employing squads tactically to gather needed information | 1 2 3 |
| Not locating self at vantage point to observe main effort | 1 2 3 |
| Not performing a leader's recon to assess terrain and situation | 1 2 3 |
| Not determining reliability/timeliness of intelligence information | 1 2 3 |
| | |
| Poor communication caused by: | |
| Not requesting information from squad leaders | 1 2 3 |
| Not requesting information from civilians | 1 2 3 |
| Not requesting information from commander | 1 2 3 |
| Not communicating key information to commander | 1 2 3 |
| | |
| Not communicating key information to squad leaders | 1 2 3 |
| Not communicating key information to other platoons | 1 2 3 |
| Not monitoring company net | 1 2 3 |
| Not communicating overall situation and Commander's Intent to squads | 1 2 3 |
| Not maintaining effective internal platoon communication | 1 2 3 |

For the following, circle two responses: one for the degree to which new platoon leaders fail to gather the information on his platoon, and one for the degree to which new platoon leaders fail to gather information on the opposing force.

- | | <u>Circle One</u>
Platoon | <u>Circle On</u>
OPFOR |
|---|--|---|
| Not determining combat readiness status: | | |
| Number and severity of casualties | 1 2 3 | 1 2 3 |
| Subordinate compliance with orders | 1 2 3 | |
| Experience and training | 1 2 3 | 1 2 3 |
| Physical fatigue | 1 2 3 | 1 2 3 |
| Mental fatigue | 1 2 3 | 1 2 3 |
| Morale | 1 2 3 | 1 2 3 |
| Movement and current position of troops | 1 2 3 | 1 2 3 |
| Weapons types, characteristics and quantities available | 1 2 3 | 1 2 3 |

Rating Scale

- 1 Not a major SA problem for new platoon leaders
- 2 Moderate SA problems for new platoon leaders
- 3 Frequent SA problems for new platoon leaders

	<u>Circle One</u> <u>Platoon</u>	<u>Circle On</u> <u>OPFOR</u>
Identification markers	1 2 3	1 2 3
Range and direction to troops	1 2 3	1 2 3
Timing and location of direct and indirect fire support (location only for OPFOR)	1 2 3	1 2 3
Ammo and supplies availability	1 2 3	1 2 3
Availability of reinforcements	1 2 3	1 2 3
Heavy weapons locations	1 2 3	1 2 3
Past behavior and tactics	1 2 3	1 2 3
Impact of current and future weather factors on mission	1 2 3	1 2 3

For the preceding section, Section A, please place a check mark beside the five items that you believe present the most serious situation awareness challenges for new platoon leaders. (Note that Section A is on two pages.)

B. Failure to COMPREHEND the situation (even though the basic information is detected) due to:

Misinterpreting the significance of the detected information	1 2 3
Not assembling bits of information together to form a coherent picture.	1 2 3
Not discerning key/critical information from maps, records, terrain models	1 2 3
Not discerning key/critical information from reports received	1 2 3
Not specifying alternate and supplemental plans/courses of actions	1 2 3
Not developing an understanding of:	
Immediacy/severity of threat	1 2 3
Commander's Intent	1 2 3
Troop morale and readiness	1 2 3
Control measures in use	1 2 3
Timing of events/tasks	1 2 3
Task priorities	1 2 3
Personal capabilities/limitations	1 2 3
Platoon capabilities/limitations	1 2 3
Equipment capabilities/limitations	1 2 3
Impact of terrain on mission and operations	1 2 3
Impact of weather on mission and operations	1 2 3
Obstacles, cover and concealment, observation points, key terrain, avenues of approach	1 2 3
Civilian population character, mood and intentions	1 2 3
Matching the right weapon to the task	1 2 3
Impact of platoon experience level on mission and operations	1 2 3
Impact of soldier load and distance traveled on troop fatigue	1 2 3
Positioning soldiers to minimize the risk of fratricide	1 2 3
Impact of troop movements on exposure	1 2 3
Current combat effectiveness	1 2 3
Enemy strengths and weaknesses	1 2 3
Likely areas of strategic significance to enemy (e.g. LP/OP locations)	1 2 3
Enemy expectations of friendly actions	1 2 3

For the preceding section, Section B, please place a check mark beside the five items that you believe present the most serious situation awareness challenges for new platoon leaders.

Rating Scale

- 1 Not a major SA problem for new platoon leaders
- 2 Moderate SA problems for new platoon leaders
- 3 Frequent SA problems for new platoon leaders

C. Failure to PROJECT future situations (though the current situation is understood) due to:

- | | | | |
|--|---|---|---|
| Overprojection of current trends | 1 | 2 | 3 |
| Lack of contingency planning | 1 | 2 | 3 |
| Not projecting the impact of future weather conditions on operations | 1 | 2 | 3 |

Failure to project the following:

- | | | | |
|---|---|---|---|
| Actions of friendly forces from available information | 1 | 2 | 3 |
| Effect of current combat power on ability to continue mission | 1 | 2 | 3 |
| Usage rate of ammunition and supplies | 1 | 2 | 3 |
| Own ability to avoid enemy contact | 1 | 2 | 3 |
| Own ability to detect enemy troops | 1 | 2 | 3 |

- | | | | |
|---|---|---|---|
| Ability to maintain communication with unit | 1 | 2 | 3 |
| Likely enemy COA from available information | 1 | 2 | 3 |
| Location of enemy troops around heavy weapons | 1 | 2 | 3 |
| Likelihood of enemy contact | 1 | 2 | 3 |

- | | | | |
|--|---|---|---|
| Likely avenues of enemy approach | 1 | 2 | 3 |
| Likely civilian actions and responses from available information | 1 | 2 | 3 |
| Interpretation of friendly actions by civilian population | 1 | 2 | 3 |
| Potential for escalation of civilian hostilities | 1 | 2 | 3 |

For the preceding section, Section C, please place a check mark beside the three items that you believe present the most serious situation awareness challenges for new platoon leaders.

D. Failure to effectively perform the necessary mission tasks due to:

- | | | | |
|---|---|---|---|
| Poor mission planning | 1 | 2 | 3 |
| Poor responses to unexpected/unplanned events | 1 | 2 | 3 |
| Poor decision making | 1 | 2 | 3 |

- | | | | |
|--------------------------|---|---|---|
| Poor skills execution | 1 | 2 | 3 |
| Poor time management | 1 | 2 | 3 |
| Poor task prioritization | 1 | 2 | 3 |

- | | | | |
|--|---|---|---|
| Inability to seek out needed information | 1 | 2 | 3 |
| Inability to understand radio communications | 1 | 2 | 3 |
| Fatigue | 1 | 2 | 3 |

For the preceding section, Section D, please place a check mark beside the three items that you believe present the most serious situation awareness challenges for new platoon leaders.

Please return completed survey to Laura Strater by March 15, 2001.

Thank you for your participation in this survey.

Appendix B

Chi-Square Test for Differences In Probabilities: Rank (Officer versus Enlisted)			
	Level 1 SA Questions Question	χ^2	p
A1	High workload	0.47	0.79
A2	Mishearing/misinterpreting information	1.38	0.50
A3	Memory failure	0.05	0.97
A4	Distractions	3.06	0.22
A5	Attentional narrowing	2.79	0.25
A6	Not determining terrain conditions	0.27	0.87
A7	Not determining significant terrain features	4.87	0.09
A8	Not determining civilian locations and activities	1.16	0.56
A9	Not setting appropriate levels of alert	9.17	0.01
A10	Not utilizing a standard reporting procedure	2.05	0.36
A11	Not carrying out standard operating procedures	5.82	0.05
A12	Not requesting pertinent intelligence information	1.88	0.39
A13	Not employing squads tactically to gather needed information	1.42	0.49
A14	Not locating self at vantage point to observe main effort	0.48	0.79
A15	Not performing a leader's recon to assess terrain and situation	1.03	0.60
A16	Not determining reliability/timeliness of intelligence information	12.15	0.00
A17	Not requesting information from squad leaders	2.21	0.33
A18	Not requesting information from civilians	0.24	0.00
A19	Not requesting information from commander	0.23	0.89
A20	Not communicating key information to commander	2.61	0.27
A21	Not communicating key information to squad leaders	3.08	0.21
A22	Not communicating key information to other platoons	4.31	0.12
A23	Not monitoring company net	1.73	0.42
A24	Not communicating overall situation and Commander's Intent to squads	11.61	0.00
A25	Not maintaining effective internal platoon communication	4.36	0.11
A26A	Number and severity of causalities	1.25	0.54
A27A	Subordinate compliance with orders	5.48	0.06
A28A	Experience and training	1.10	0.58
A29A	Physical fatigue	1.67	0.43
A30A	Mental fatigue	6.63	0.04
A31A	Morale	0.40	0.82
A32A	Movement and current position of troops	7.96	0.02
A33A	Weapons types, characteristics and quantities available	0.87	0.65
A34A	Identification markers	0.06	0.97
A35A	Range and direction to troops	2.87	0.24
A36A	Timing and location of direct and indirect fire support	2.99	0.22
A37A	Ammo and supplies availability	3.70	0.16
A38A	Availability of reinforcements	2.35	0.31
A39A	Heavy weapons locations	2.97	0.23
A40A	Past behavior and tactics	0.30	0.86
A41A	Impact of current and future weather factors on mission	4.63	0.10
A26B	Number and severity of causalities	1.28	0.53
A28B	Experience and training	5.00	0.08
A29B	Physical fatigue	2.61	0.27
A30B	Mental fatigue	6.31	0.04
A31B	Morale	4.23	0.12

A32B	Movement and current position of troops	10.34	0.01
A33B	Weapons types, characteristics and quantities available	2.50	0.29
A34B	Identification markers	8.26	0.02
A35B	Range and direction to troops	4.54	0.10
A36B	Timing and location of direct and indirect fire support	4.31	0.12
A37B	Ammo and supplies availability	1.22	0.54
A38B	Availability of reinforcements	2.11	0.35
A39B	Heavy weapons locations	4.50	0.11
A40B	Past behavior and tactics	3.88	0.14
A41B	Impact of current and future weather factors on mission	8.01	0.02

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test for Differences In Probabilities*: Rank (Officer versus Enlisted)			
	Level 2 SA Question	χ^2	p
B1	Misinterpreting the significance of the detected information	8.70	0.01
B2	Not assembling bits of information together to form a coherent picture	5.02	0.08
B3	Not discerning key/critical information from maps, records, terrain models	2.07	0.35
B4	Not discerning key/critical information from reports received	6.12	0.05
B5	Not specifying alternate and supplemental plans/courses of actions	1.82	0.40
B6	Immediacy/severity of threat	8.88	0.01
B7	Commander's Intent	8.98	0.01
B8	Troop morale and readiness	1.67	0.43
B9	Control measures in use	0.60	0.74
B10	Timing of events/tasks	8.53	0.01
B11	Task priorities	3.39	0.18
B12	Personal capabilities/limitations	0.46	0.79
B13	Platoon capabilities/limitations	3.38	0.18
B14	Equipment capabilities/limitations	1.09	0.58
B15	Impact of terrain on mission and operations	3.55	0.17
B16	Impact of Weather on Mission and Operations	1.65	0.44
B17	Obstacles, cover, and concealment, observation points, key terrain, avenues of approach	3.37	0.19
B18	Civilian population character, mood and intentions	5.09	0.07
B19	Matching the right weapon to the task	0.81	0.67
B20	Impact of platoon experience level on mission and operations	2.67	0.26
B21	Impact of soldier load and distance traveled on troop fatigue	0.82	0.66
B22	Positioning soldiers to minimize the risk of fratricide	8.17	0.02
B23	Impact of troop movements on exposure	0.27	0.87
B24	Current combat effectiveness	1.42	0.49
B25	Enemy strengths and weaknesses	8.25	0.02
B26	Likely areas of strategic significance to enemy	7.93	0.02
B27	Enemy expectations of friendly actions	6.34	0.04

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test For Differences in Probabilities: Rank (Officer versus Enlisted)			
	Level 3 SA Question	χ^2	p
C1	Overprojection of Current Trends	3.35	0.19
C2	Lack of Contingency Planning	2.04	0.36
C3	Not Projecting the Impact of Future Weather Conditions on Operations	0.97	0.62
C4	Actions of Friendly Forces from Available Information	5.98	0.05
C5	Effect of Current Combat Power on Ability to Continue Mission	5.45	0.07
C6	Usage Rate of Ammunition and Supplies	1.47	0.48
C7	Own Ability to Avoid Enemy Contact	2.26	0.32
C8	Own Ability to Detect Enemy Troops	2.16	0.34
C9	Ability to Maintain Communication with Unit	4.64	0.10
C10	Likely Enemy COA from Available Information	3.11	0.21
C11	Location of Enemy Troops Around Heavy Weapons	4.50	0.11
C12	Likelihood of Enemy Contact	4.14	0.13
C13	Likely Avenues of Enemy Approach	9.29	0.01
C14	Likely Civilian Actions and Responses from Available Information	1.21	0.55
C15	Interpretation of Friendly Actions by Civilian Population	3.09	0.21
C16	Potential for Escalation of Civilian Hostilities	0.11	0.95

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test for Differences in Probabilities: Rank (Officer versus Enlisted)			
	Performance Question	χ^2	p
D1	Poor Mission Planning	2.52	0.28
D2	Poor Responses to Unexpected/Unplanned Events	1.45	0.49
D3	Poor Decision Making	0.72	0.70
D4	Poor Skills Execution	2.58	0.28
D5	Poor Time Management	2.79	0.25
D6	Poor Task Prioritization	1.66	0.44
D7	Inability to Seek Out Needed Information	5.80	0.05
D8	Inability to Understand Radio Communications	0.75	0.69
D9	Fatigue	0.13	0.94

* Two sided test, $\alpha = .05$, $df = 2$

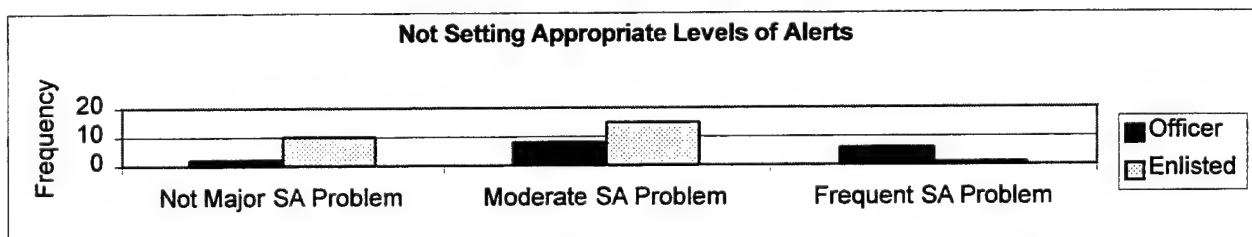


Figure B – 1 Not Setting Appropriate Levels of Alert

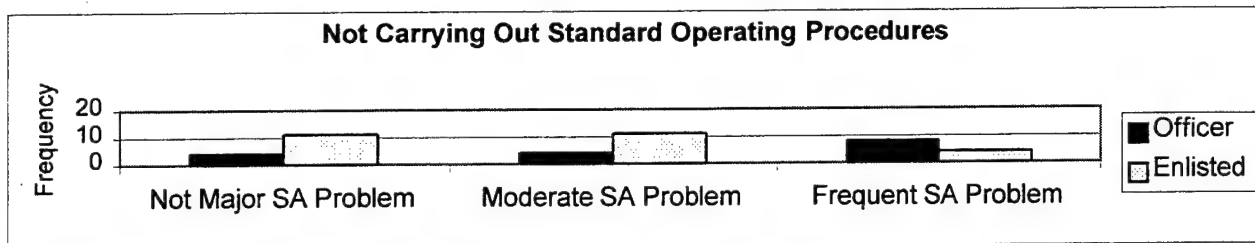


Figure B – 2. Not Carrying Out Standard Operating Procedures

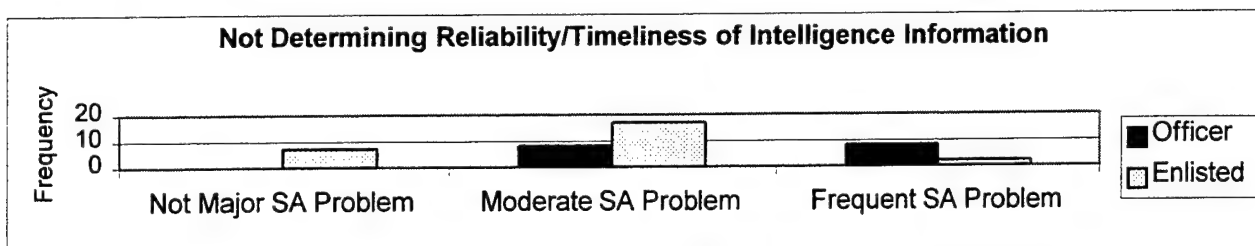


Figure B – 3. Not Determining Reliability of Intelligence Information

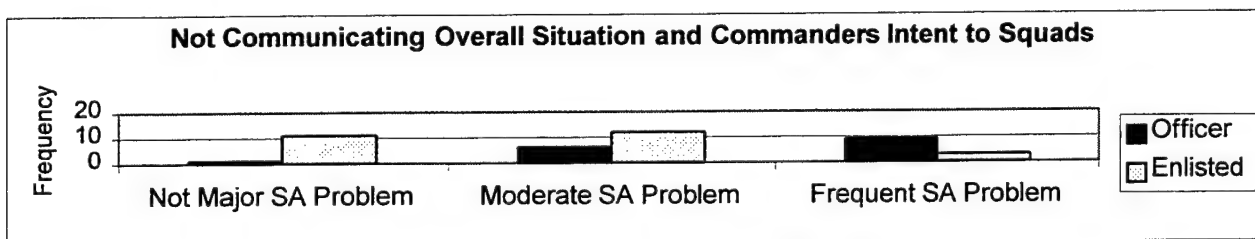


Figure B – 4. Not Communicating Commander's Intent to Squads

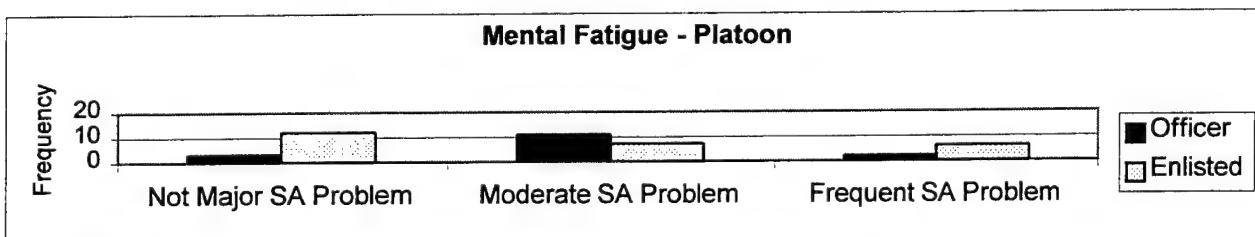


Figure B – 5. Not Detecting the Mental Fatigue of Own Platoon

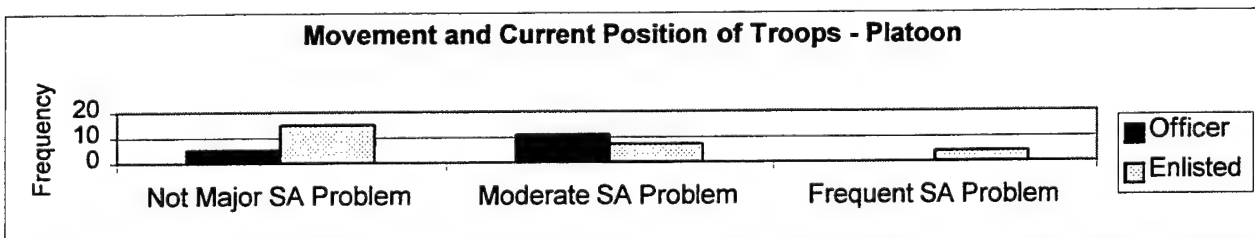


Figure B – 6. Not Detecting the Current Position of Own Platoon

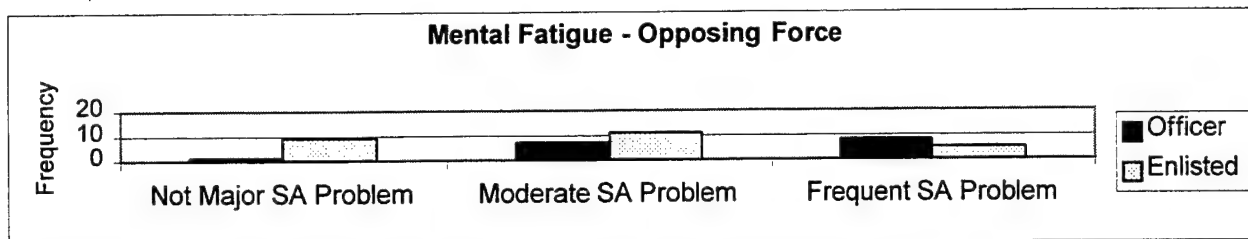


Figure B – 7. Not Detecting the Mental Fatigue of the Opposing Force

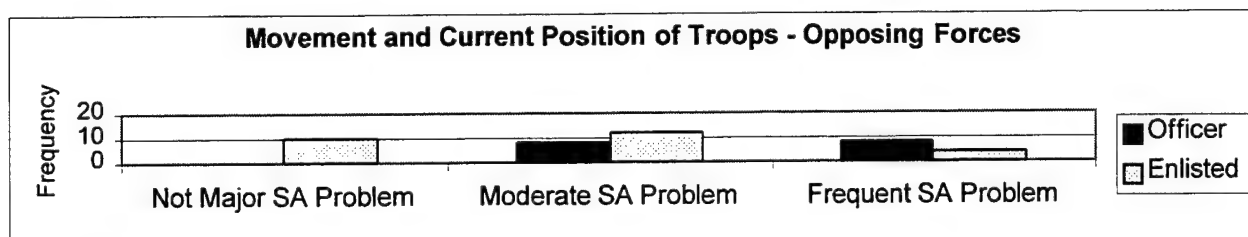


Figure B – 8. Not Detecting Movement and Position of Opposing Force

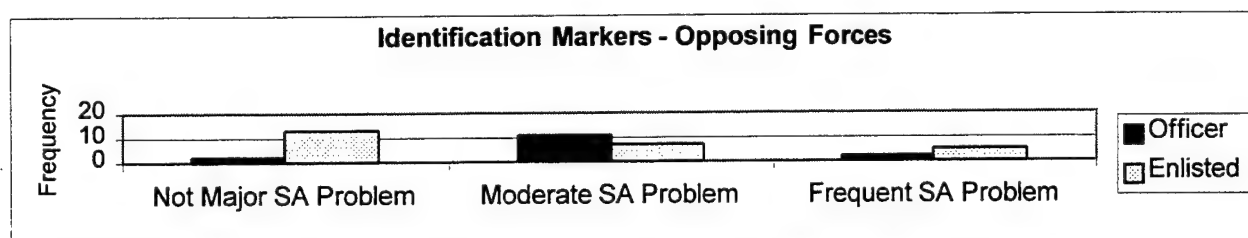


Figure B – 9. Not Detecting the Identification Markers of the Opposing Force

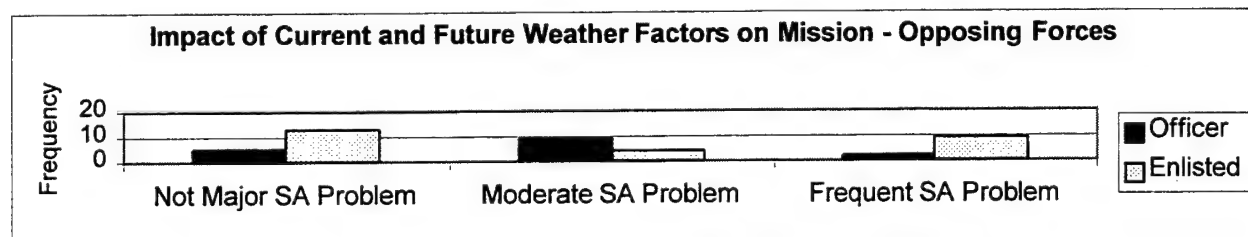


Figure B – 10. Impact of Current and Future Weather Factors on Mission

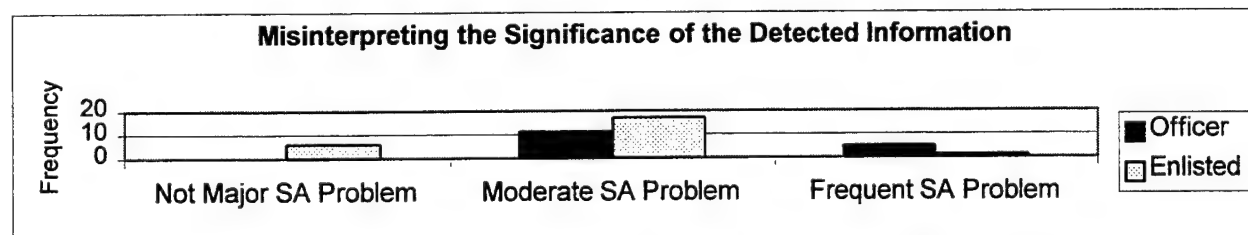


Figure B – 11. Misinterpreting the Significance of the Detected Information

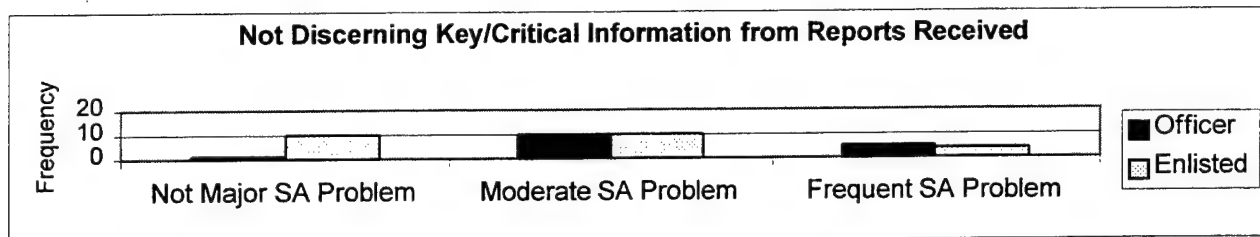


Figure B – 12. Not Discerning Key Information from Reports Received

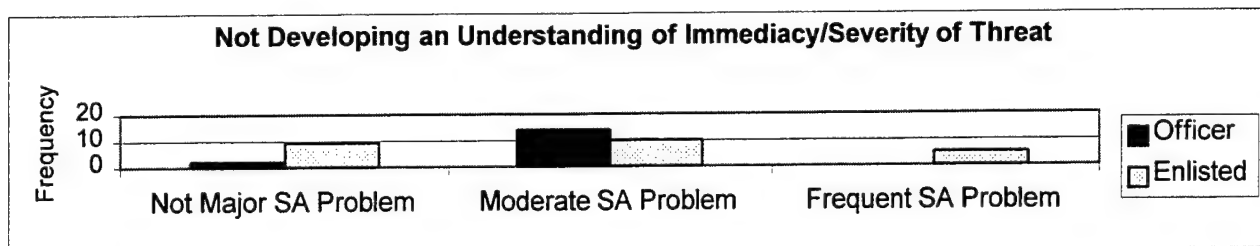


Figure B – 13. Not Understanding the Immediacy/Severity of the Threat

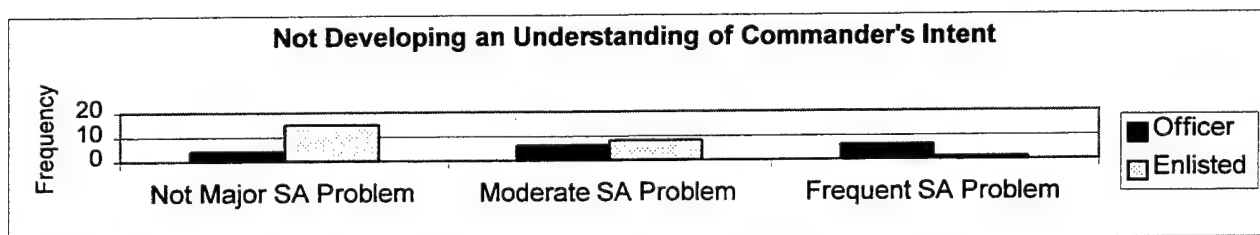


Figure B – 14. Not Developing an Understanding of Commander's Intent

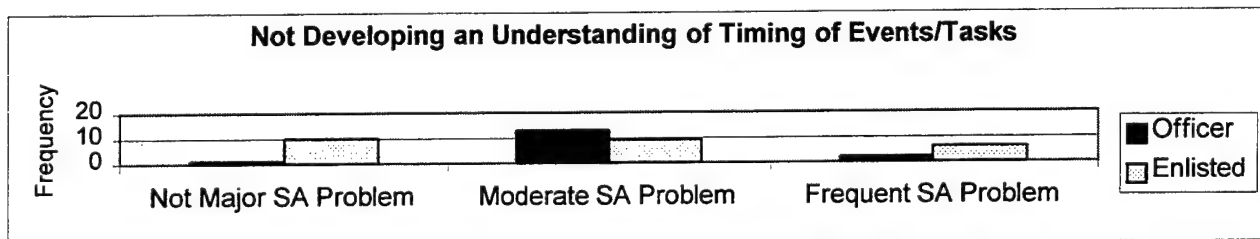


Figure B – 15. Not Developing an Understanding of Timing of Events/Tasks

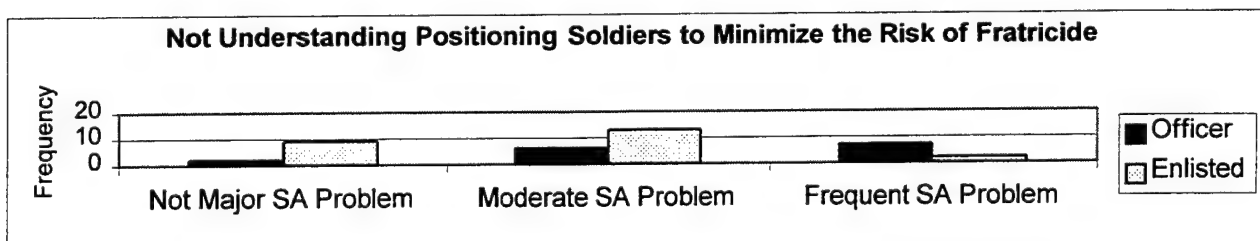


Figure B – 16. Positioning Soldiers to Minimize Risk of Fratricide

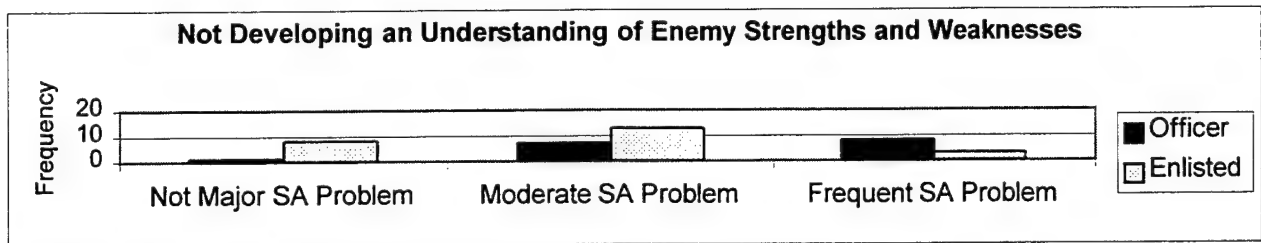


Figure B – 17. Not Understanding Enemy Strengths and Weaknesses

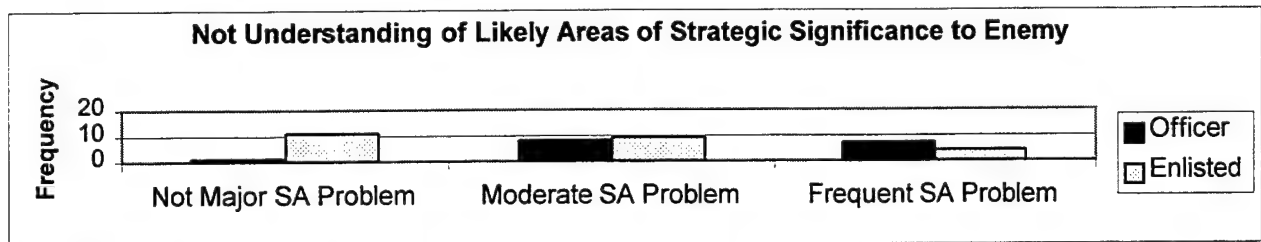


Figure B – 18. Likely Areas of Strategic Significance to Enemy

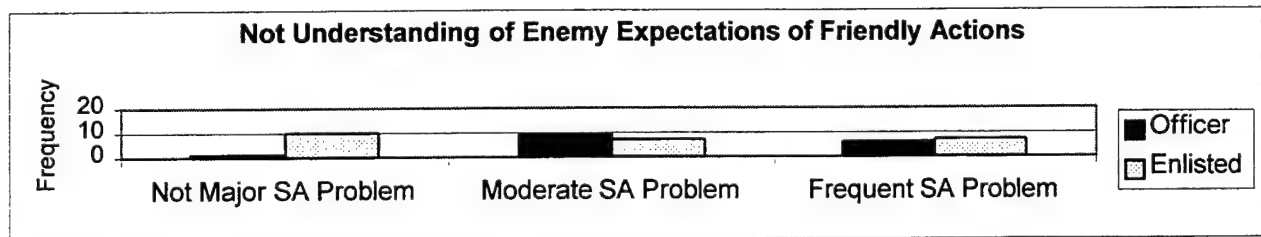


Figure B – 19. Enemy Expectations of Friendly Actions

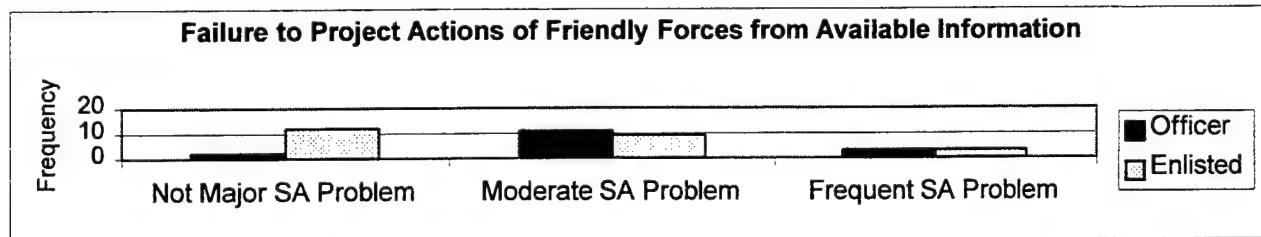


Figure B – 20. Project Actions of Friendly Forces from Available Information

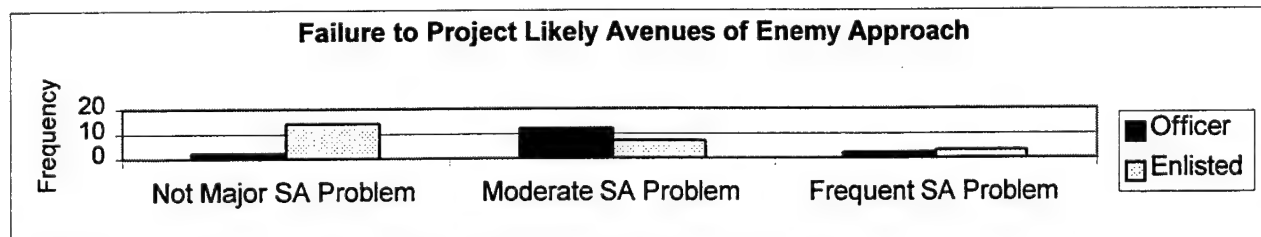


Figure B – 21. Project Likely Avenues of Enemy Approach

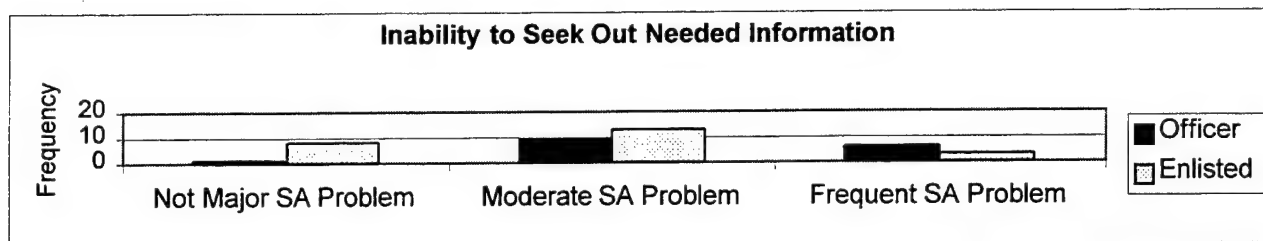


Figure B – 22. Inability to Seek Out Needed Information

Appendix C

Chi-Square Test for Differences In Probabilities*				
Primarily Trained Platoon Leaders with Specified Time In Grade				
< 12 months versus > 12 months				
Level 1 SA Question			X ²	p
A1	High workload		7.81	0.02
A2	Mishearing/misinterpreting information		5.21	0.07
A3	Memory failure		1.26	0.53
A4	Distractions		0.26	0.88
A5	Attentional narrowing		1.88	0.39
A6	Not determining terrain conditions		0.75	0.69
A7	Not determining significant terrain features		2.22	0.33
A8	Not determining civilian locations and activities		0.08	0.96
A9	Not setting appropriate levels of alert		0.71	0.70
A10	Not utilizing a standard reporting procedure		6.70	0.04
A11	Not carrying out standard operating procedures		4.78	0.09
A12	Not requesting pertinent intelligence information		0.46	0.79
A13	Not employing squads tactically to gather needed information		0.64	0.72
A14	Not locating self at vantage point to observe main effort		2.77	0.25
A15	Not performing a leader's recon to assess terrain and situation		1.68	0.43
A16	Not determining reliability/timeliness of intelligence information		0.31	0.85
A17	Not requesting information from squad leaders		2.18	0.34
A18	Not requesting information from civilians		5.61	0.00
A19	Not requesting information from commander		8.18	0.02
A20	Not communicating key information to commander		1.73	0.42
A21	Not communicating key information to squad leaders		3.49	0.17
A22	Not communicating key information to other platoons		0.08	0.96
A23	Not monitoring company net		8.46	0.01
A24	Not communicating overall situation and Commander's Intent to squads		2.15	0.34
A25	Not maintaining effective internal platoon communication		4.79	0.09
A26A	Number and severity of casualties		0.26	0.88
A27A	Subordinate compliance with orders		0.56	0.76
A28A	Experience and training		5.03	0.08
A29A	Physical fatigue		1.57	0.46
A30A	Mental fatigue		1.05	0.59
A31A	Morale		7.65	0.02
A32A	Movement and current position of troops		2.94	0.23
A33A	Weapons types, characteristics and quantities available		0.35	0.84
A34A	Identification markers		1.62	0.44
A35A	Range and direction to troops		3.15	0.21
A36A	Timing and location of direct and indirect fire support		2.80	0.25
A37A	Ammo and supplies availability		2.85	0.24
A38A	Availability of reinforcements		2.50	0.29
A39A	Heavy weapons locations		6.02	0.05
A40A	Past behavior and tactics		0.29	0.86
A41A	Impact of current and future weather factors on mission		1.26	0.53
A26B	Number and severity of casualties		8.10	0.02
A28B	Experience and training		0.21	0.90
A29B	Physical fatigue		2.65	0.27
A30B	Mental fatigue		0.16	0.92
A31B	Morale		2.26	0.32
A32B	Movement and current position of troops		1.80	0.41

A33B	Weapons types, characteristics and quantities available	5.28	0.07
A34B	Identification markers	0.22	0.90
A35B	Range and direction to troops	0.08	0.96
A36B	Timing and location of direct and indirect fire support	5.50	0.06
A37B	Ammo and supplies availability	0.64	0.72
A38B	Availability of reinforcements	2.36	0.31
A39B	Heavy weapons locations	2.50	0.29
A40B	Past behavior and tactics	1.90	0.39
A41B	Impact of current and future weather factors on mission	1.77	0.41

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test for Differences In Probabilities*			
Primarily Trained Platoon Leaders with Specified Time In Grade			
< 12 months versus > 12 months			
Level 2 SA Question		χ^2	p
B1	Misinterpreting the significance of the detected information	1.79	0.41
B2	Not assembling bits of information together to form a coherent picture	1.11	0.57
B3	Not discerning key/critical information from maps, records, terrain models	4.57	0.10
B4	Not discerning key/critical information from reports received	3.63	0.16
B5	Not specifying alternate and supplemental plans/courses of actions	0.02	0.99
B6	Immediacy/severity of threat	2.02	0.36
B7	Commander's Intent	8.52	0.01
B8	Troop morale and readiness	0.27	0.87
B9	Control measures in use	8.28	0.02
B10	Timing of events/tasks	0.69	0.71
B11	Task priorities	3.03	0.22
B12	Personal capabilities/limitations	9.04	0.01
B13	Platoon capabilities/limitations	2.05	0.36
B14	Equipment capabilities/limitations	1.68	0.43
B15	Impact of terrain on mission and operations	0.08	0.96
B16	Impact of Weather on Mission and Operations	1.71	0.42
B17	Obstacles, cover, and concealment, observation points, key terrain, avenues of approach	0.28	0.87
B18	Civilian population character, mood and intentions	2.08	0.00
B19	Matching the right weapon to the task	4.09	0.13
B20	Impact of platoon experience level on mission and operations	1.25	0.53
B21	Impact of soldier load and distance traveled on troop fatigue	1.31	0.52
B22	Positioning soldiers to minimize the risk of fratricide	1.42	0.49
B23	Impact of troop movements on exposure	2.47	0.29
B24	Current combat effectiveness	2.52	0.28
B25	Enemy strengths and weaknesses	0.24	0.89
B26	Likely areas of strategic significance to enemy	0.32	0.85
B27	Enemy expectations of friendly actions	5.56	0.06

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test for Differences In Probabilities*			
	Primarily Trained Platoon Leaders with Specified Time In Grade		
	< 12 months versus > 12 months		
	Level 3 SA Question	χ^2	p
C1	Overprojection of Current Trends	5.64	0.06
C2	Lack of Contingency Planning	5.54	0.06
C3	Not Projecting the Impact of Future Weather Conditions on Operations	4.98	0.08
C4	Actions of Friendly Forces from Available Information	0.91	0.63
C5	Effect of Current Combat Power on Ability to Continue Mission	4.77	0.09
C6	Usage Rate of Ammunition and Supplies	1.25	0.54
C7	Own Ability to Avoid Enemy Contact	1.28	0.53
C8	Own Ability to Detect Enemy Troops	0.21	0.90
C9	Ability to Maintain Communication with Unit	2.30	0.32
C10	Likely Enemy COA from Available Information	0.17	0.92
C11	Location of Enemy Troops Around Heavy Weapons	0.82	0.66
C12	Likelihood of Enemy Contact	5.19	0.07
C13	Likely Avenues of Enemy Approach	0.76	0.68
C14	Likely Civilian Actions and Responses from Available Information	9.85	0.01
C15	Interpretation of Friendly Actions by Civilian Population	5.01	0.08
C16	Potential for Escalation of Civilian Hostilities	10.73	0.00

* Two sided test, $\alpha = .05$, $df = 2$

Chi-Square Test for Differences In Probabilities*			
	Primarily Trained Platoon Leaders with Specified Time In Grade		
	< 12 months versus > 12 months		
	Performance Question	χ^2	p
D1	Poor Mission Planning	5.49	0.06
D2	Poor Responses to Unexpected/Unplanned Events	0.03	0.00
D3	Poor Decision Making	4.68	0.10
D4	Poor Skills Execution	1.14	0.56
D5	Poor Time Management	0.35	0.84
D6	Poor Task Prioritization	3.26	0.20
D7	Inability to Seek Out Needed Information	0.70	0.70
D8	Inability to Understand Radio Communications	0.18	0.91
D9	Fatigue	0.66	0.72

* Two sided test, $\alpha = .05$, $df = 2$

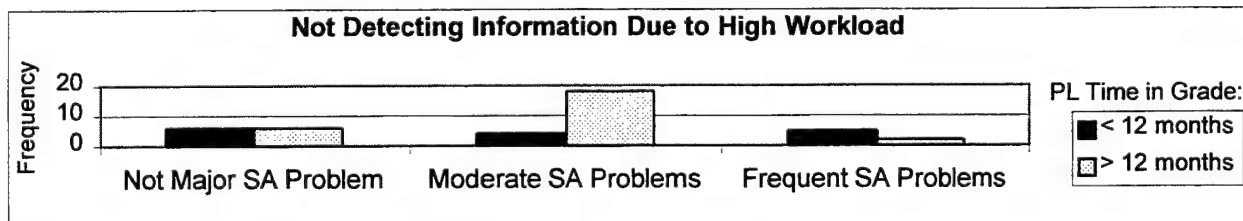


Figure C – 1. Not Detecting Information Due to High Workload

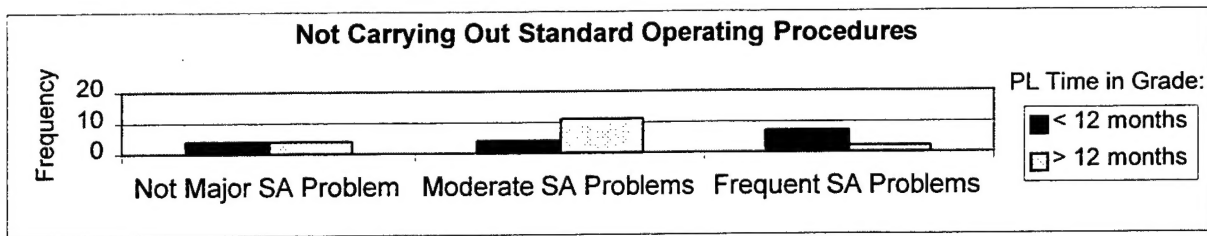


Figure C – 2. Not Carrying Out Standard Operating Procedure

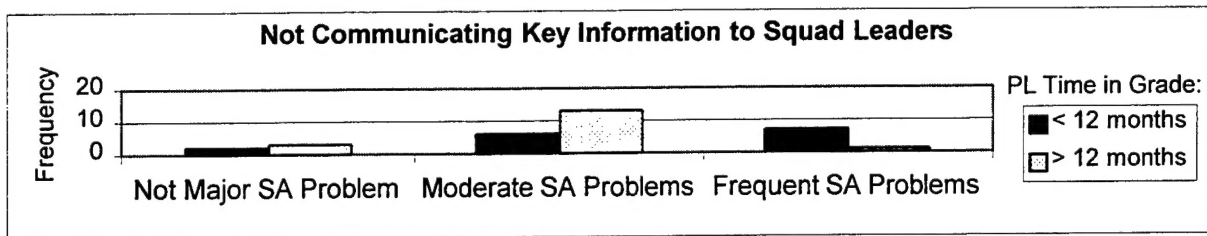


Figure C – 3. Not Communicating Key Information to Squad Leaders

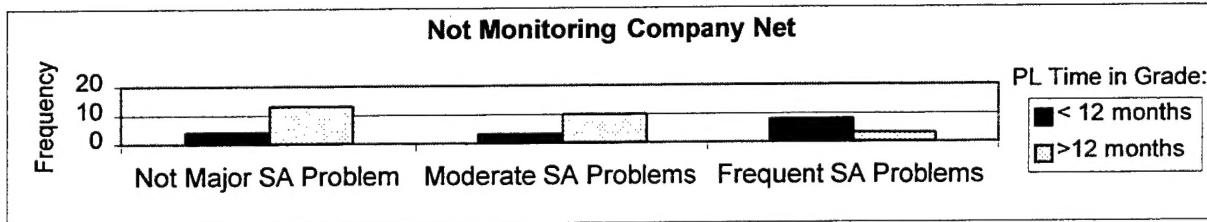


Figure C – 4. Not Monitoring Company Net

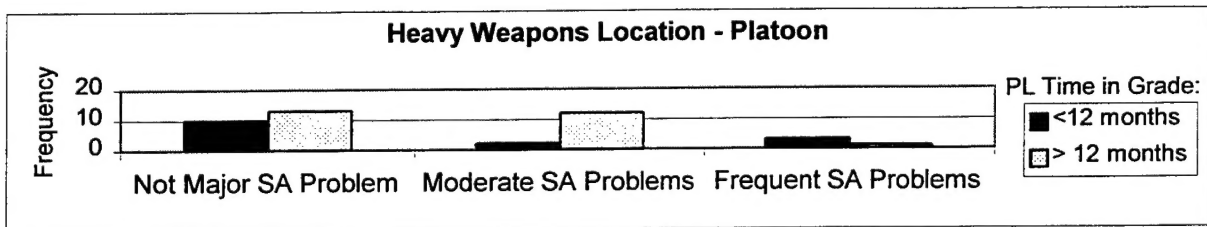


Figure C – 5. Not Detecting Heavy Weapons Location – Own Platoon

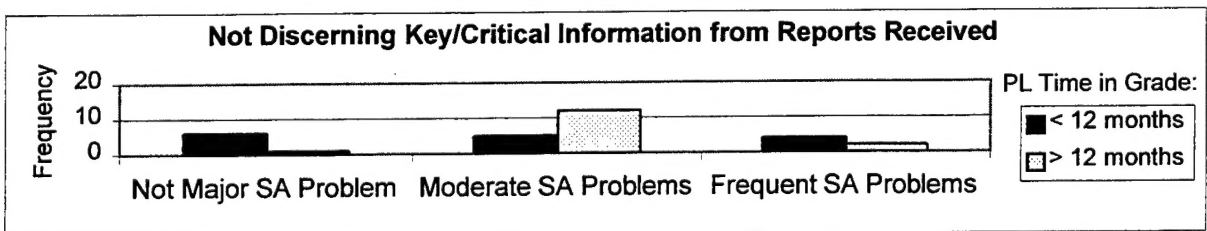


Figure C – 6. Not Discerning Key Information from Reports Received

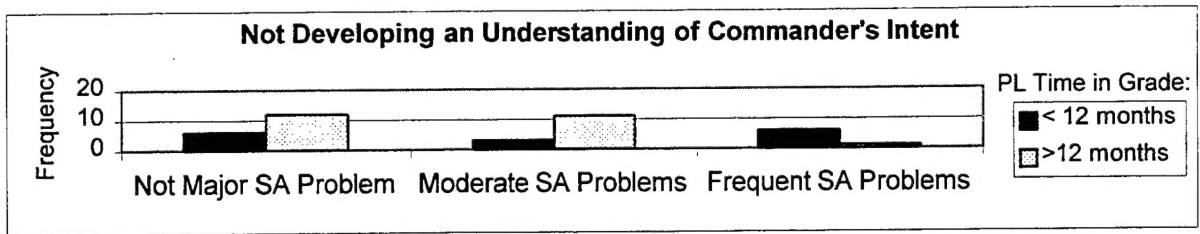


Figure C – 7. Not Developing an Understanding of Commander's Intent

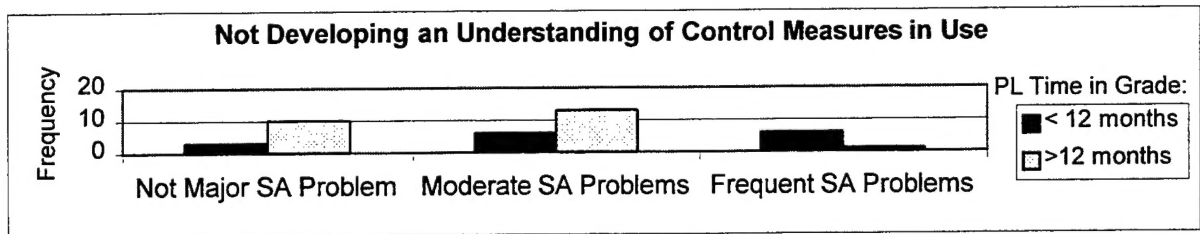


Figure C – 8. Not Developing an Understanding of Control Measures in Use

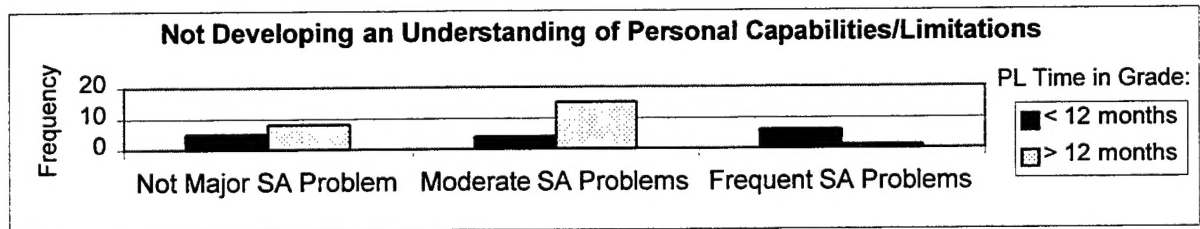


Figure C – 9. Not Developing an Understanding of Personal Capabilities

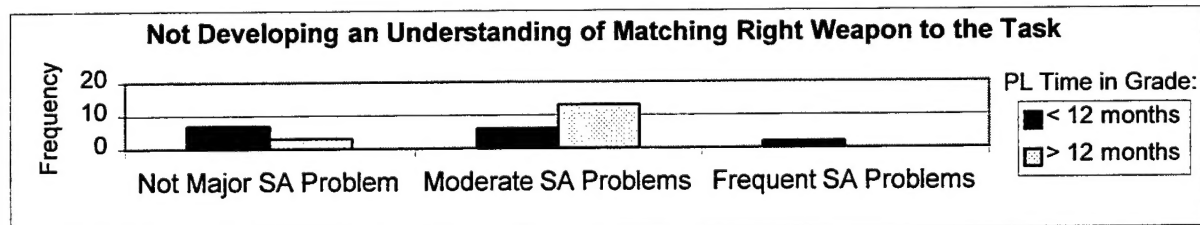


Figure C – 10. Not Developing an Understanding of Matching a Weapon to the Task

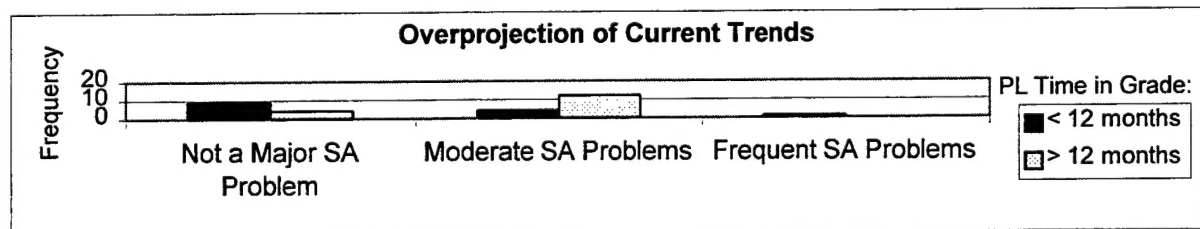


Figure C – 11. Overprojection of Current Trends

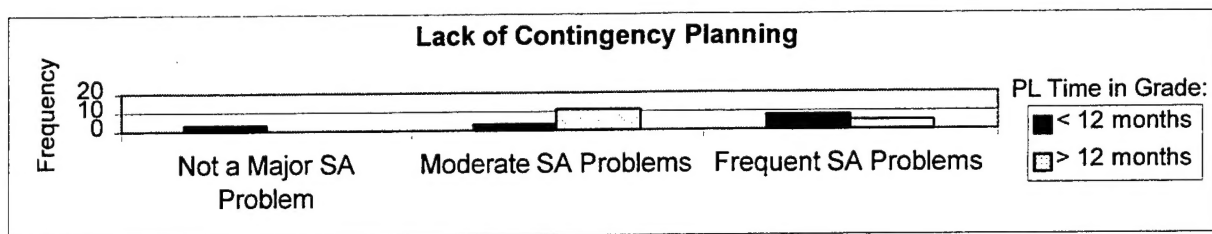


Figure C – 12 Lack of Contingency Planning

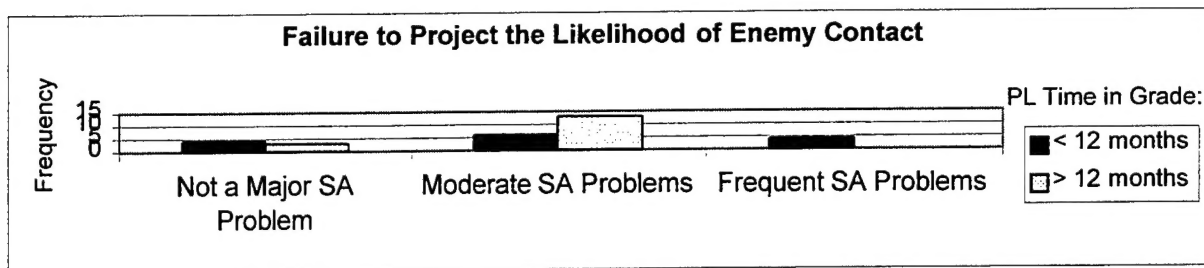


Figure C – 13. Failure to Project the Likelihood of Enemy Contact

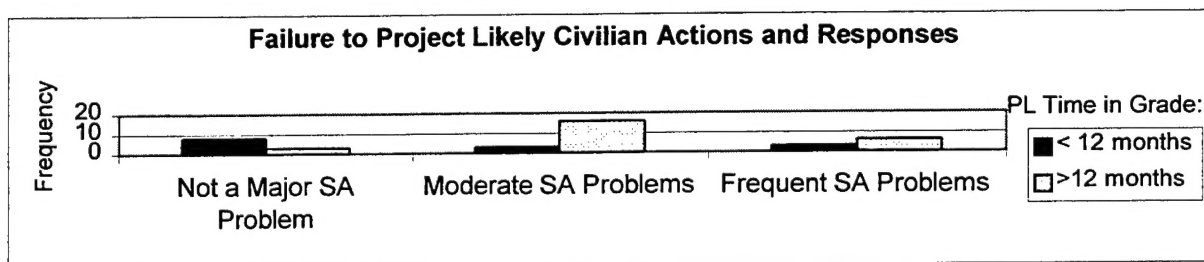


Figure C – 14. Failure to Project Likely Civilian Actions and Responses from Available Information

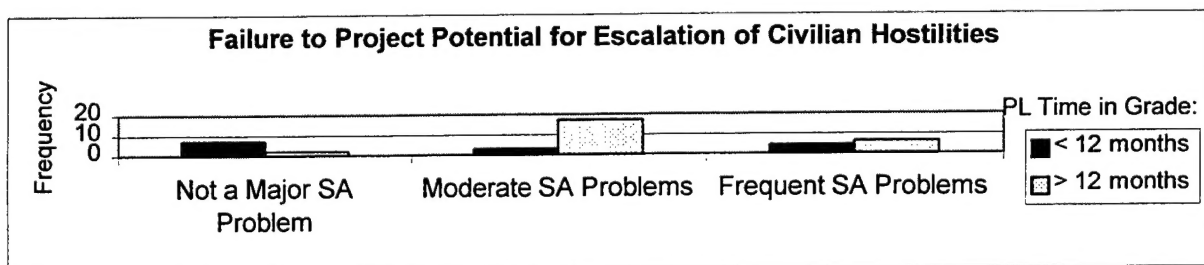


Figure C – 15. Failure to Project Potential for Escalation of Civilian Hostilities

APPENDIX D: Acronyms

AAR–After Action Review

ANOVA –Analysis of Variance

AO–Area of Operations

ARI – Army Research Institute

AT – Anti-Tank

CI –Commander’s Intent

CO–Commanding Officer

COA–Course of Action

FRAGO – Fragmentary Order

GUI – Graphical User Interface

NBC–Nuclear, Biological, Chemical Weapons

O/C –Observer/Controller

SA – Situation Awareness

SAGAT – Situation Awareness Global Assessment Technique

SITREP – Situation Report

SME – Subject Matter Expert

SOP – Standard Operating Procedure

SRP – Standard Reporting Procedures

SVS–Soldier Visualization System

WIA – Wounded in Action